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B65G 47/46

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B8A ACA AT1 AT3 A24
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(54) Distribution apparatus

(57) Distribution apparatus for sorting and distribution loads such as parcels includes an array of stations juxtaposed to form a matrix having at least one input station for receiving a load, a plurality of output stations and a plurality of transfer stations each adapted to transfer loads therein in a selected one of a plurality of directions. Control means are provided to direct said load from said input station to a predetermined one of the output stations via a plurality of said transfer stations.

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Fig.1.

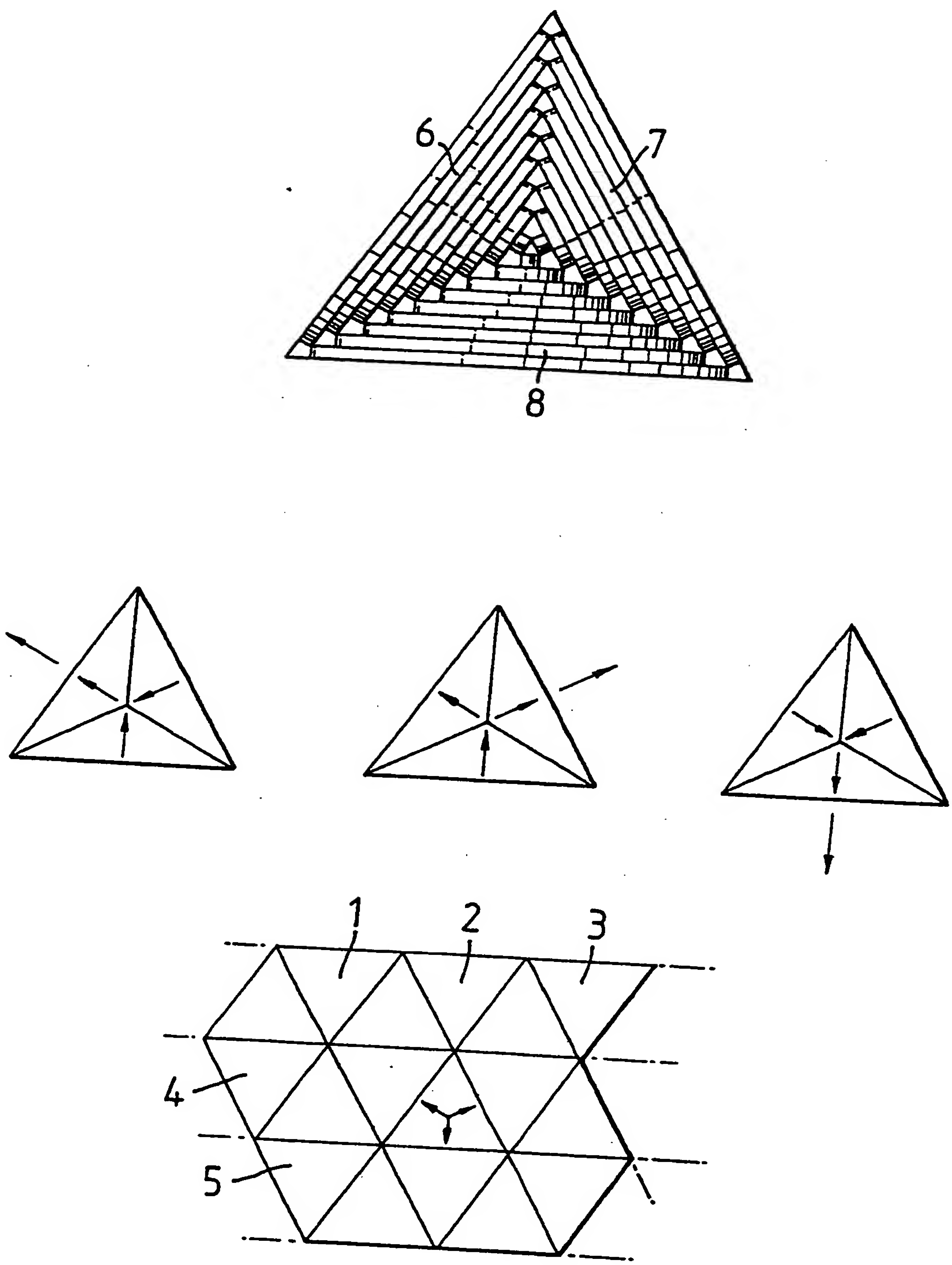


Fig. 2.

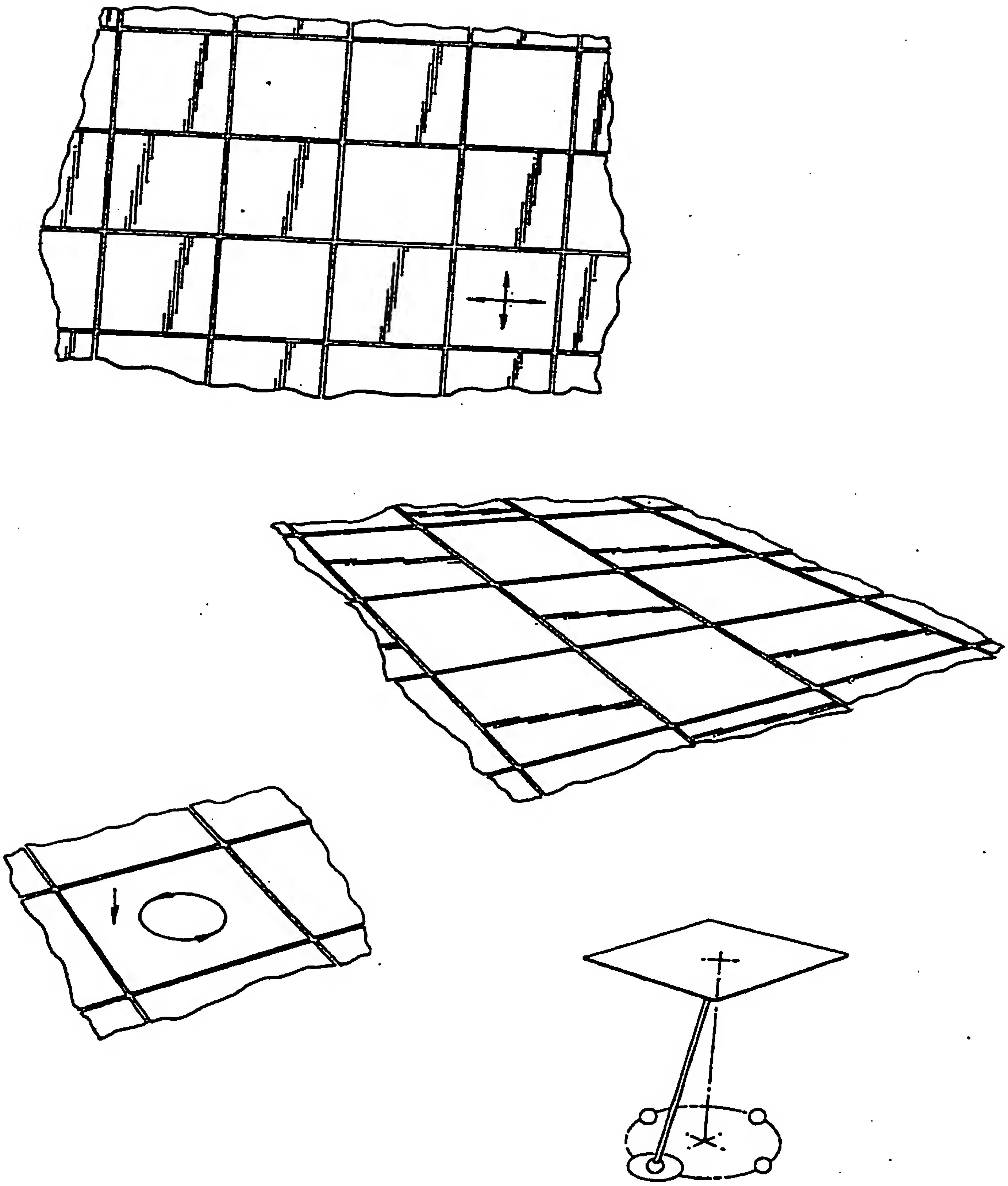
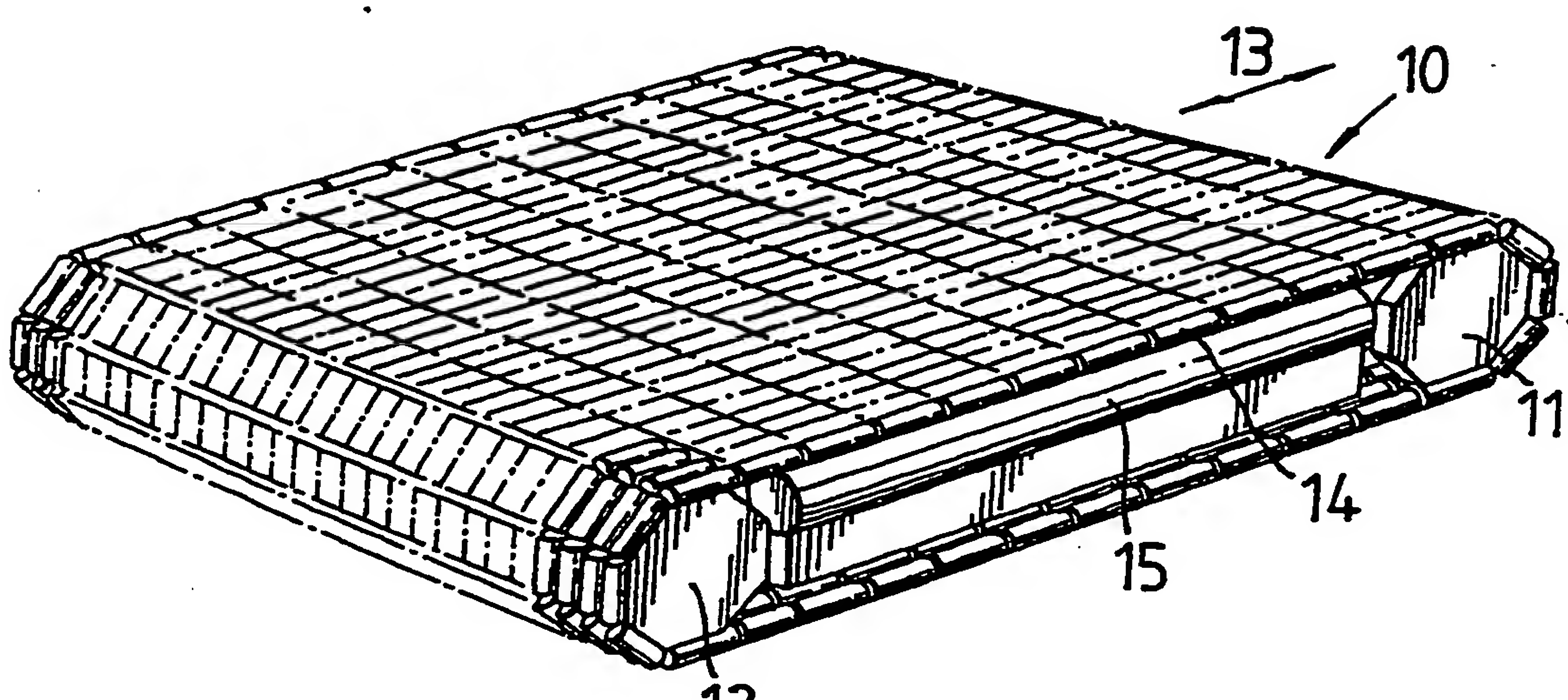


Fig. 3.



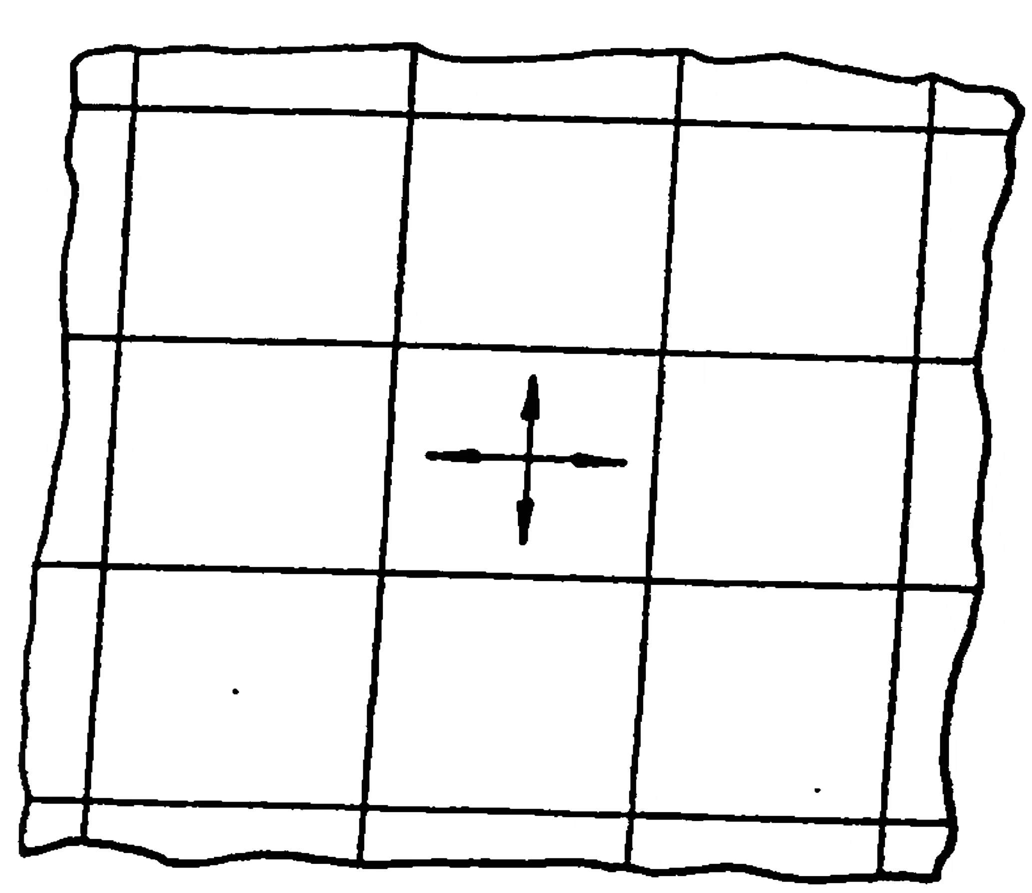


Fig. 4.

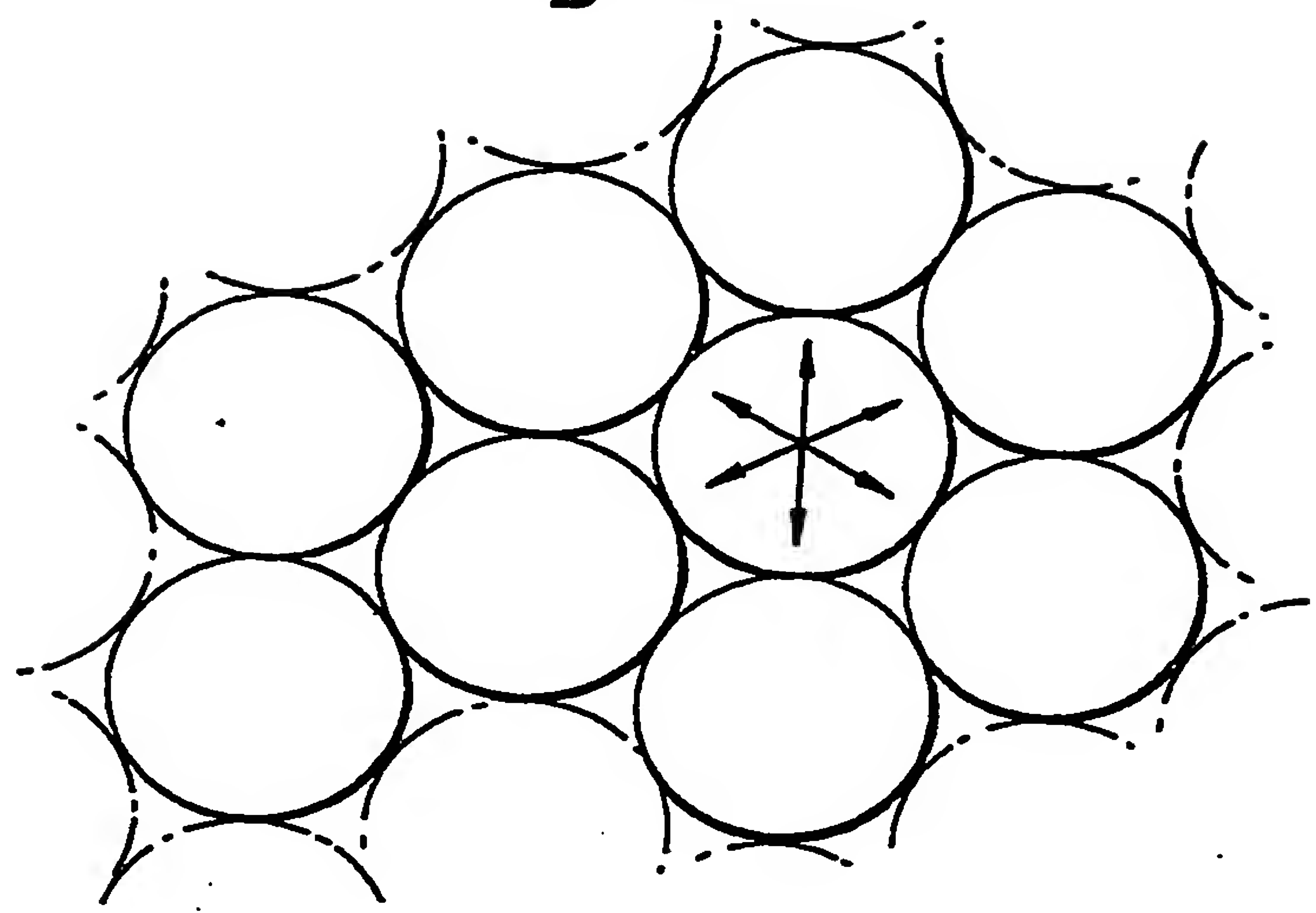


Fig. 4a.

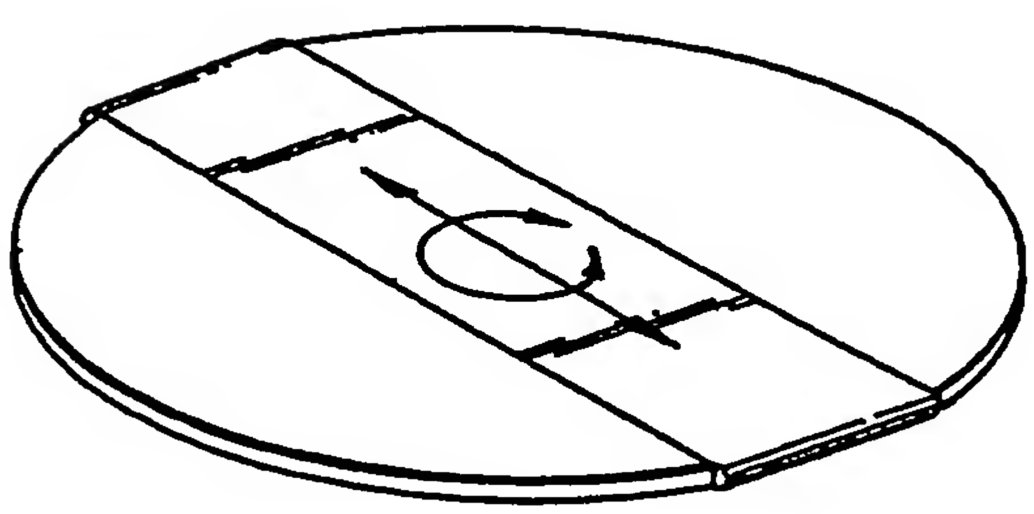


Fig. 4b.

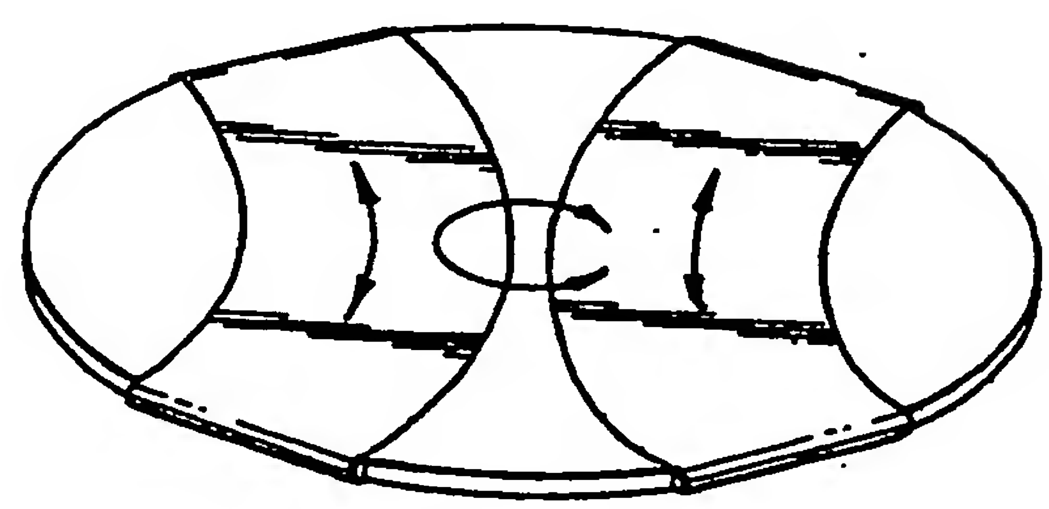


Fig. 4c.

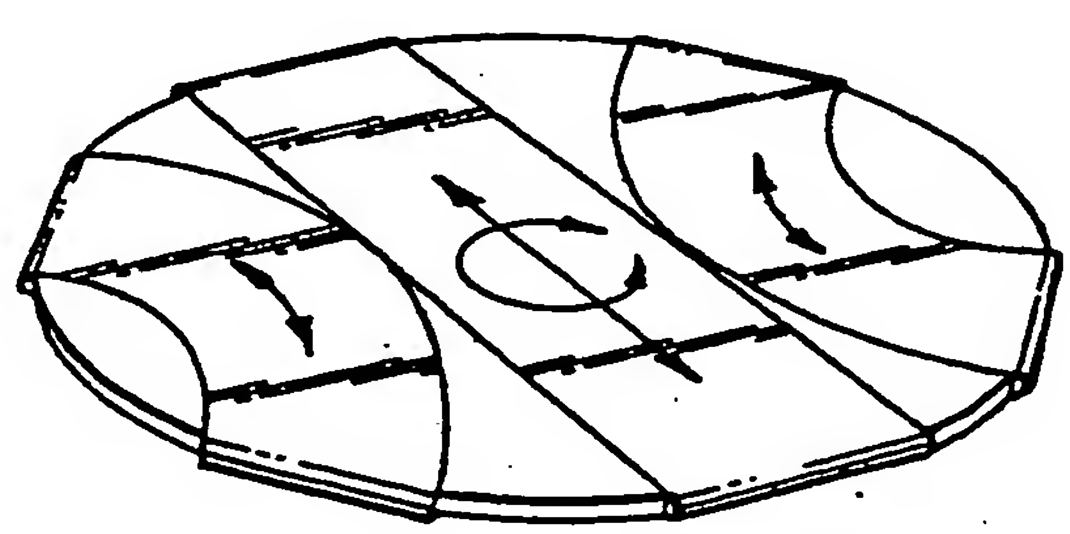
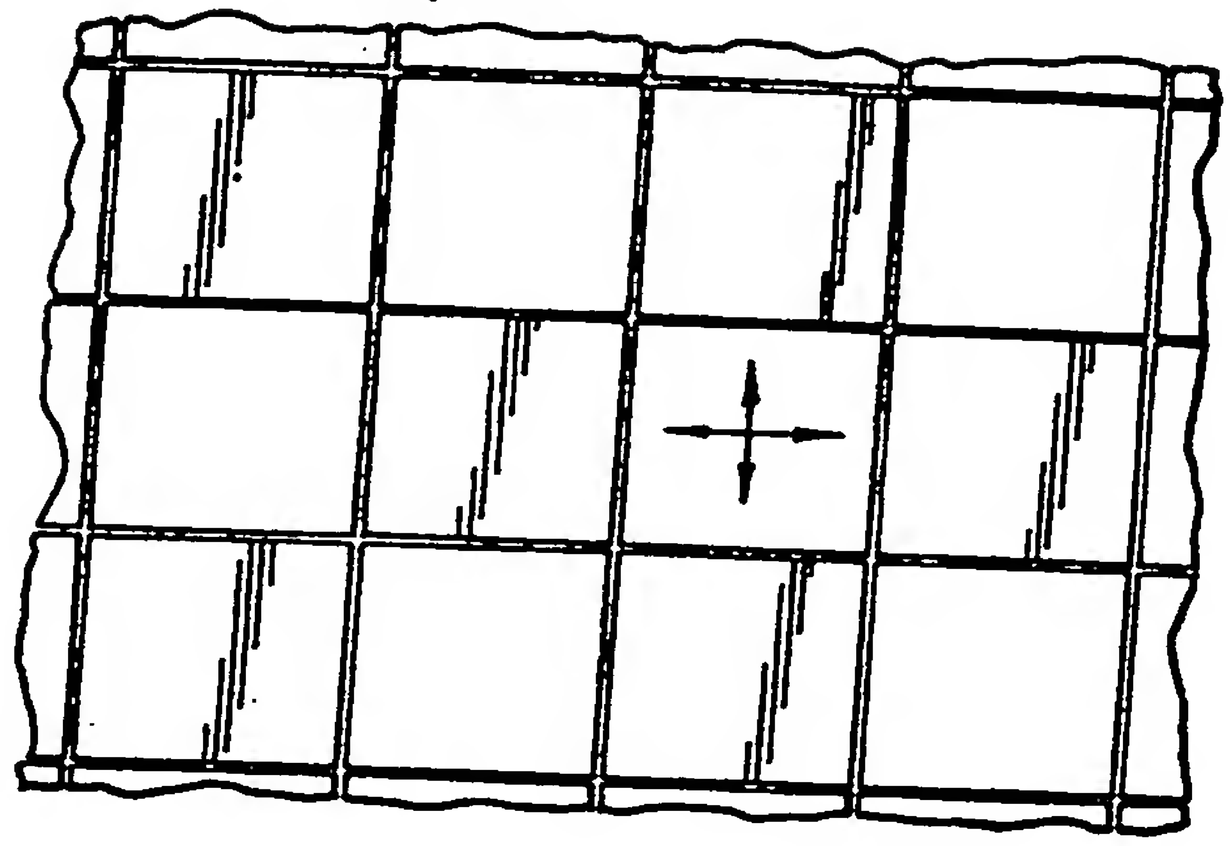
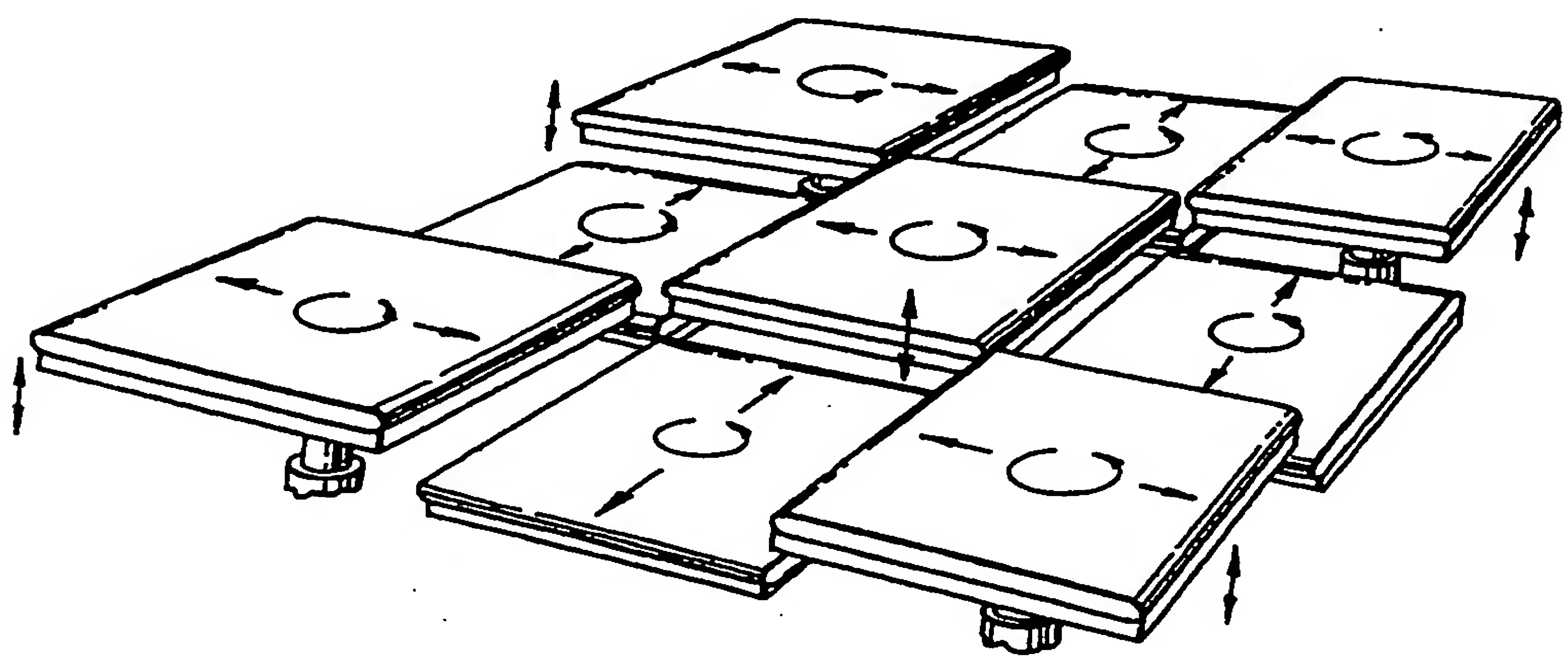


Fig.5.





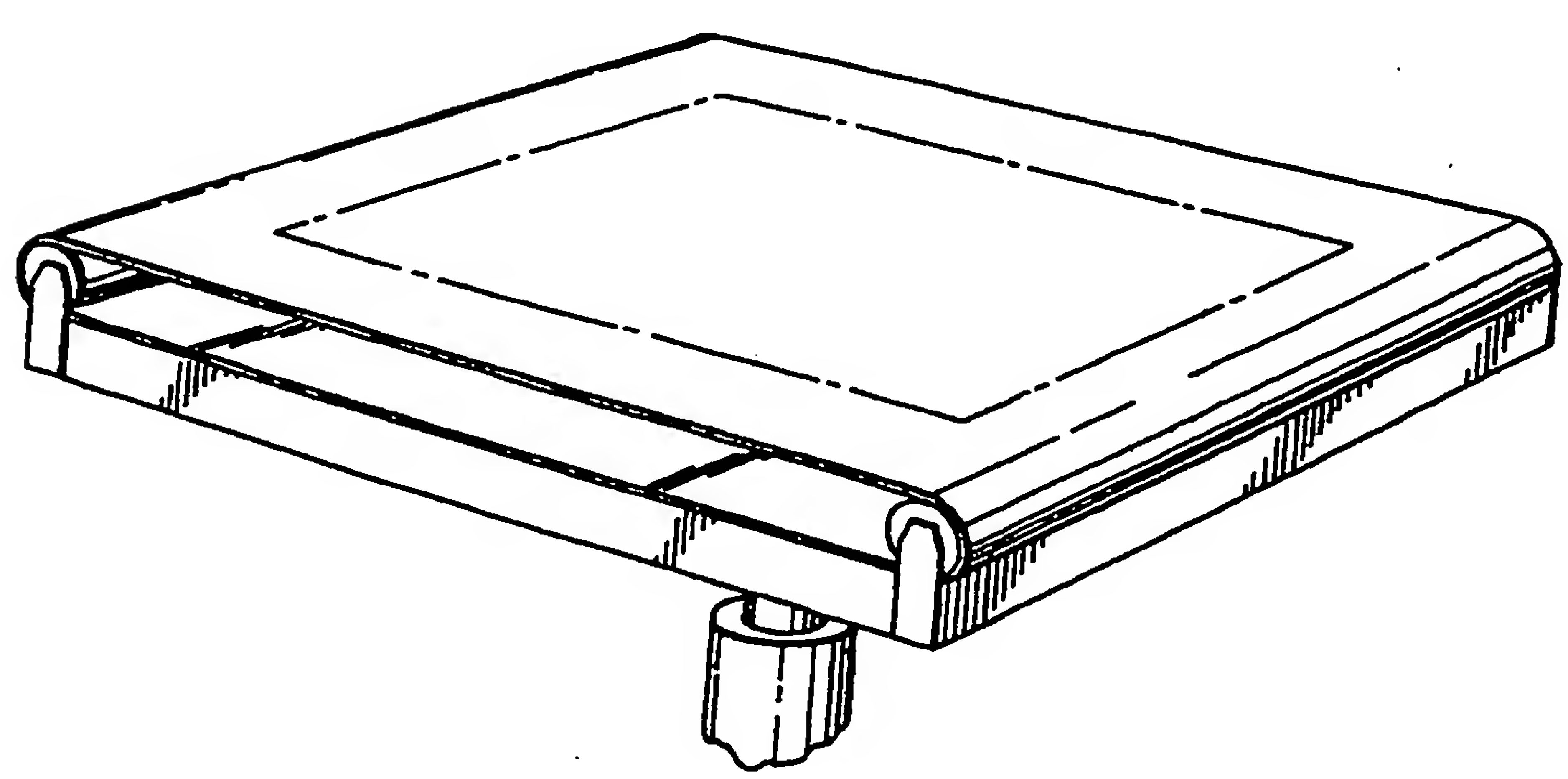
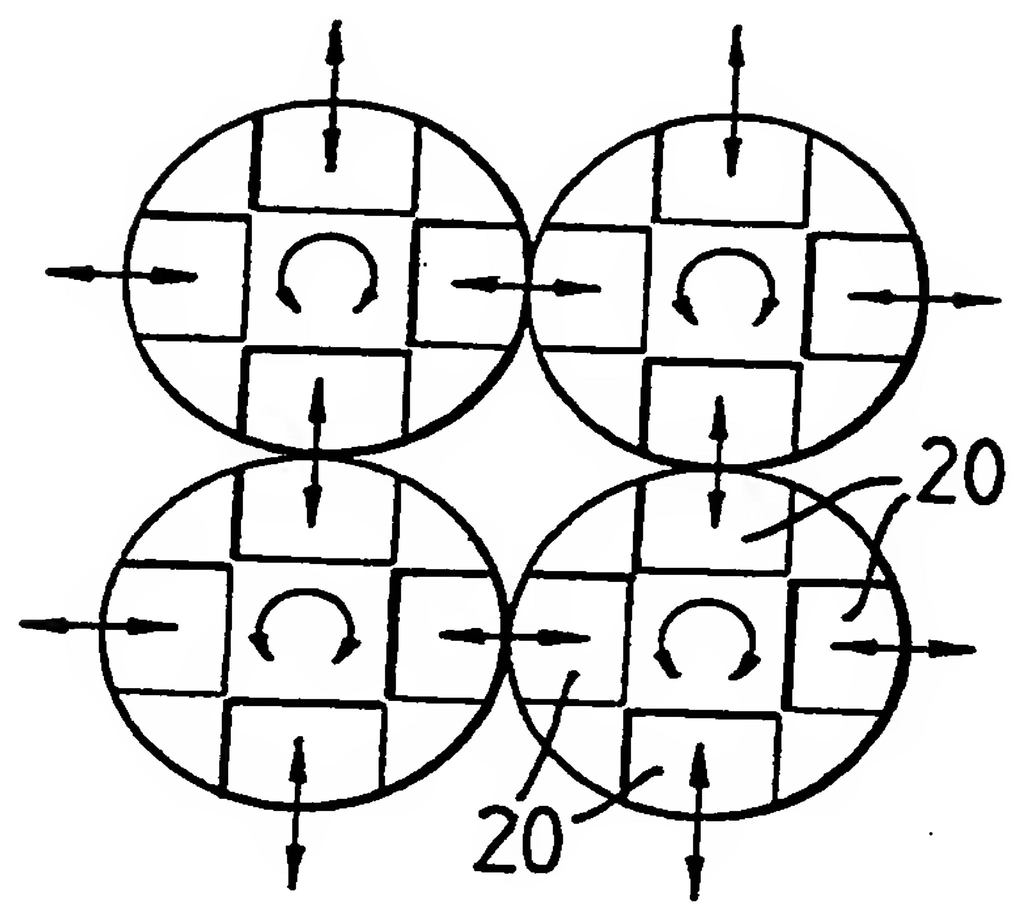
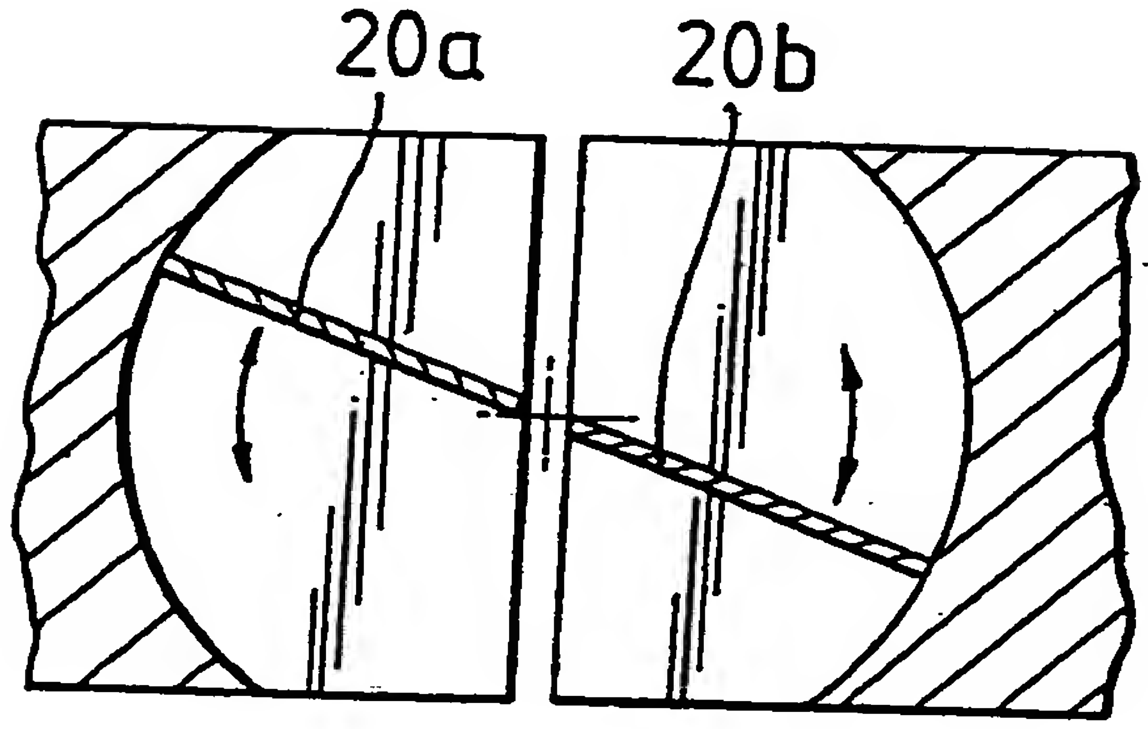


Fig. 6.





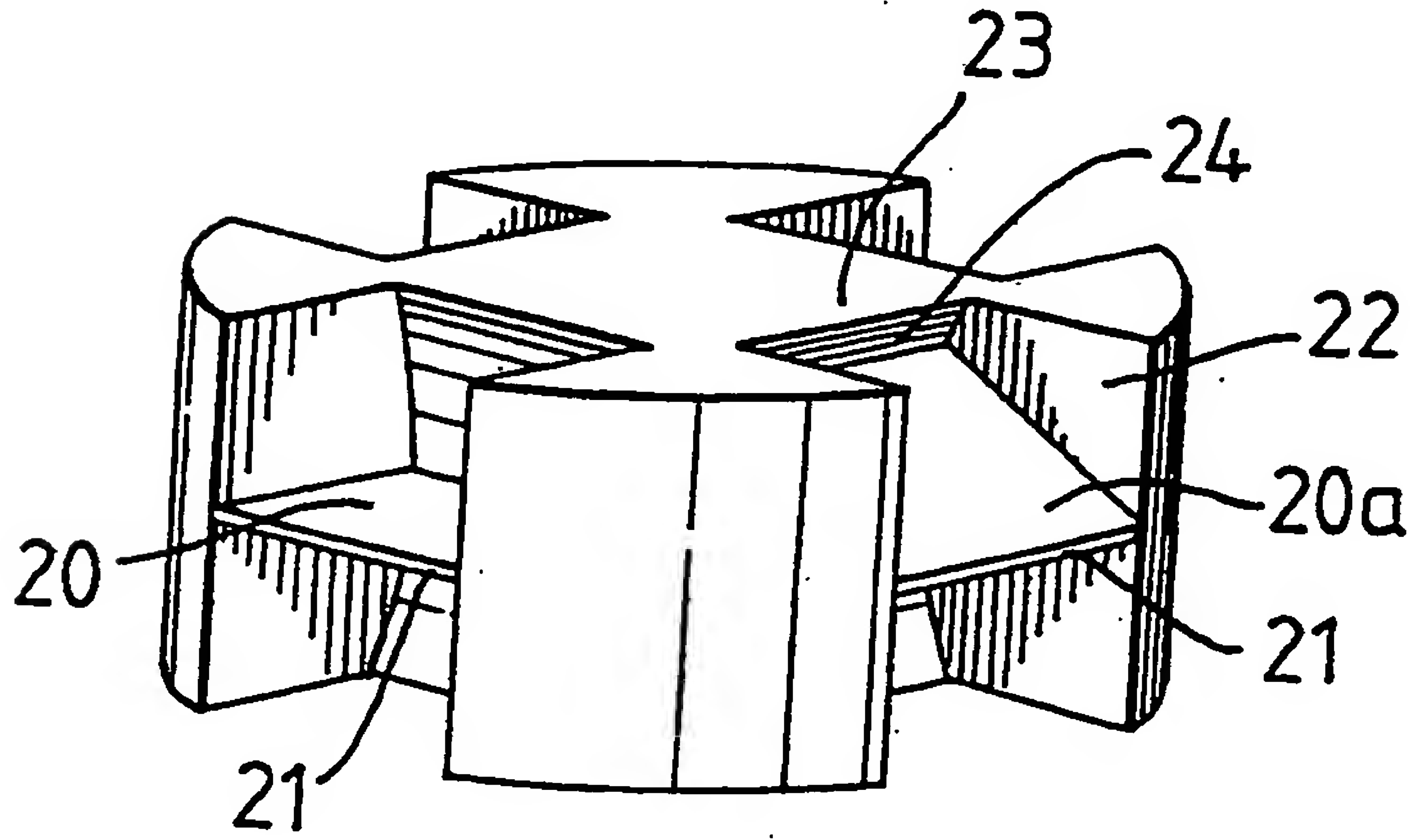
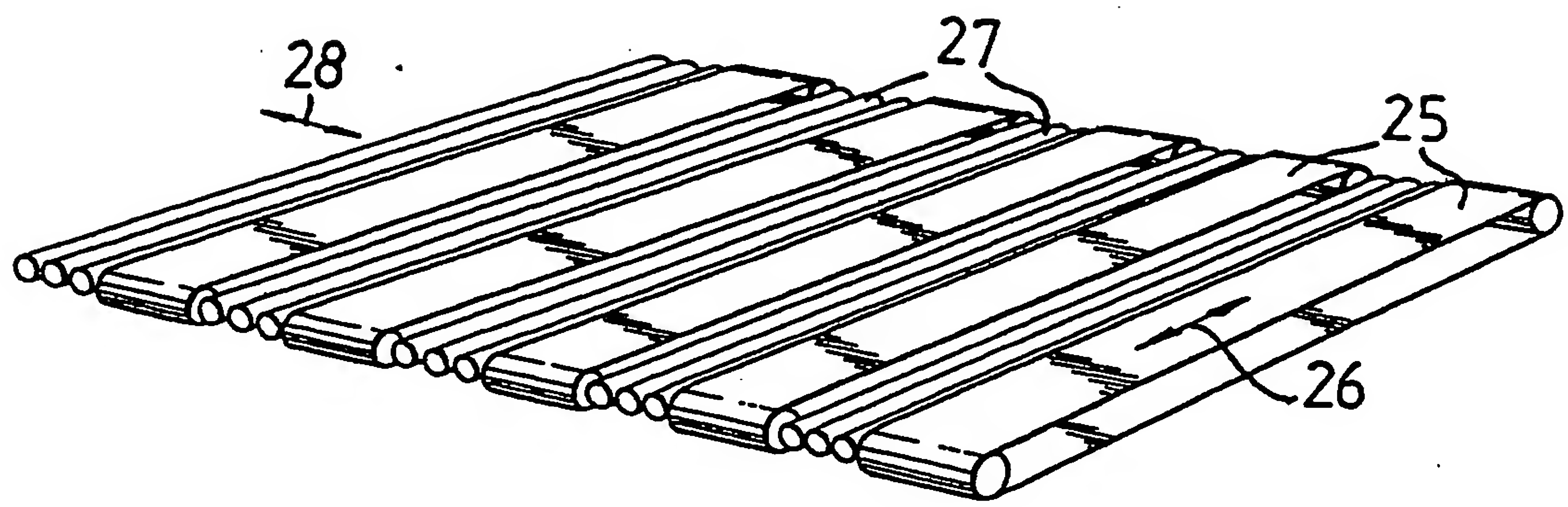
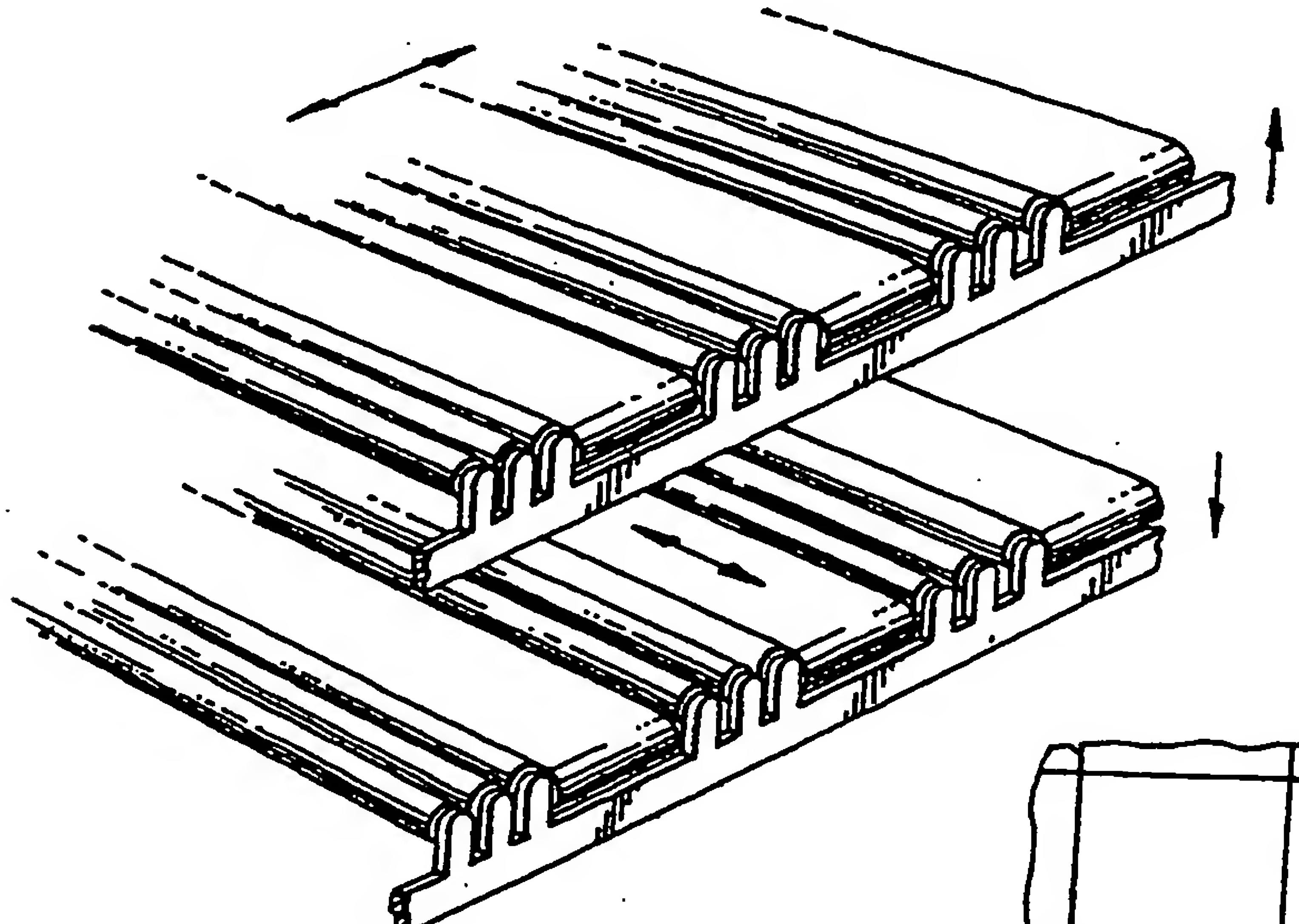


Fig. 7.





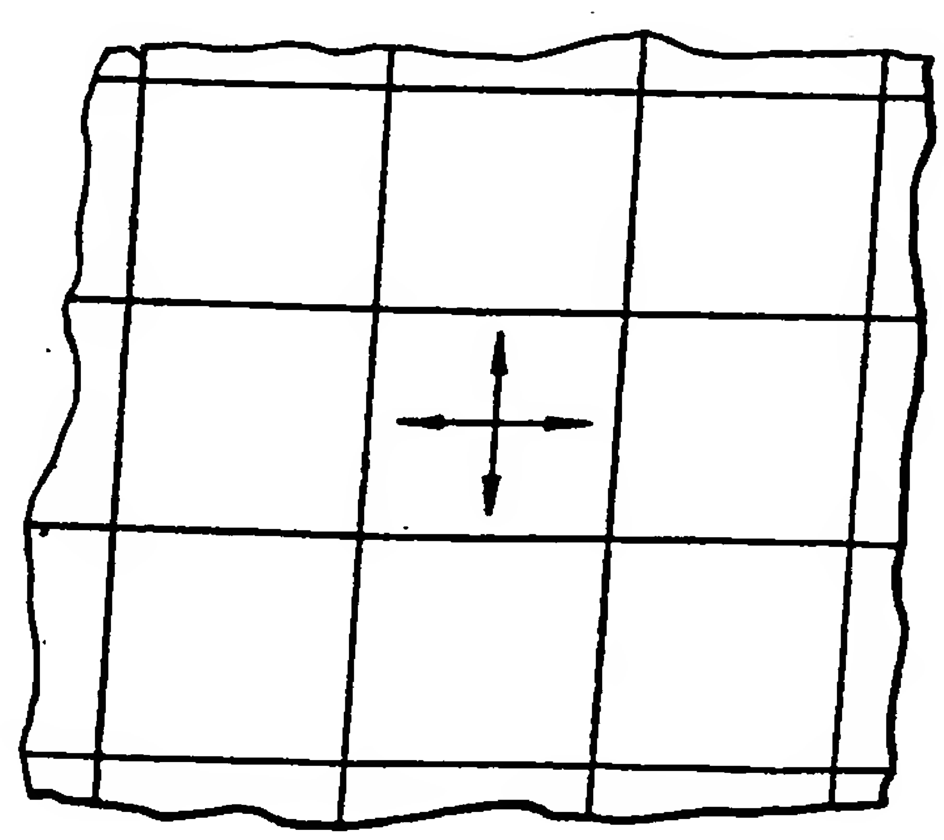


Fig.8.

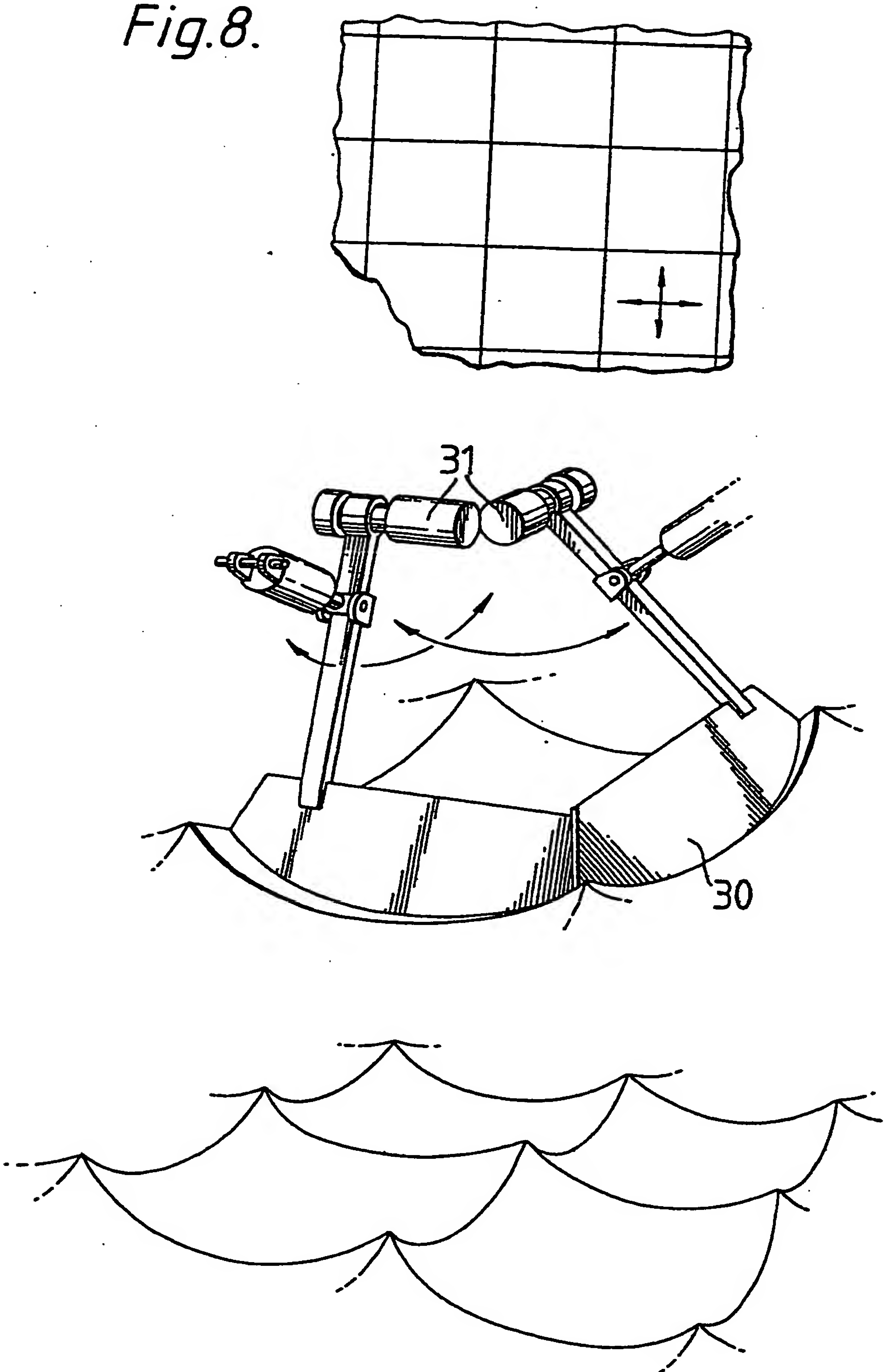


Fig.9.

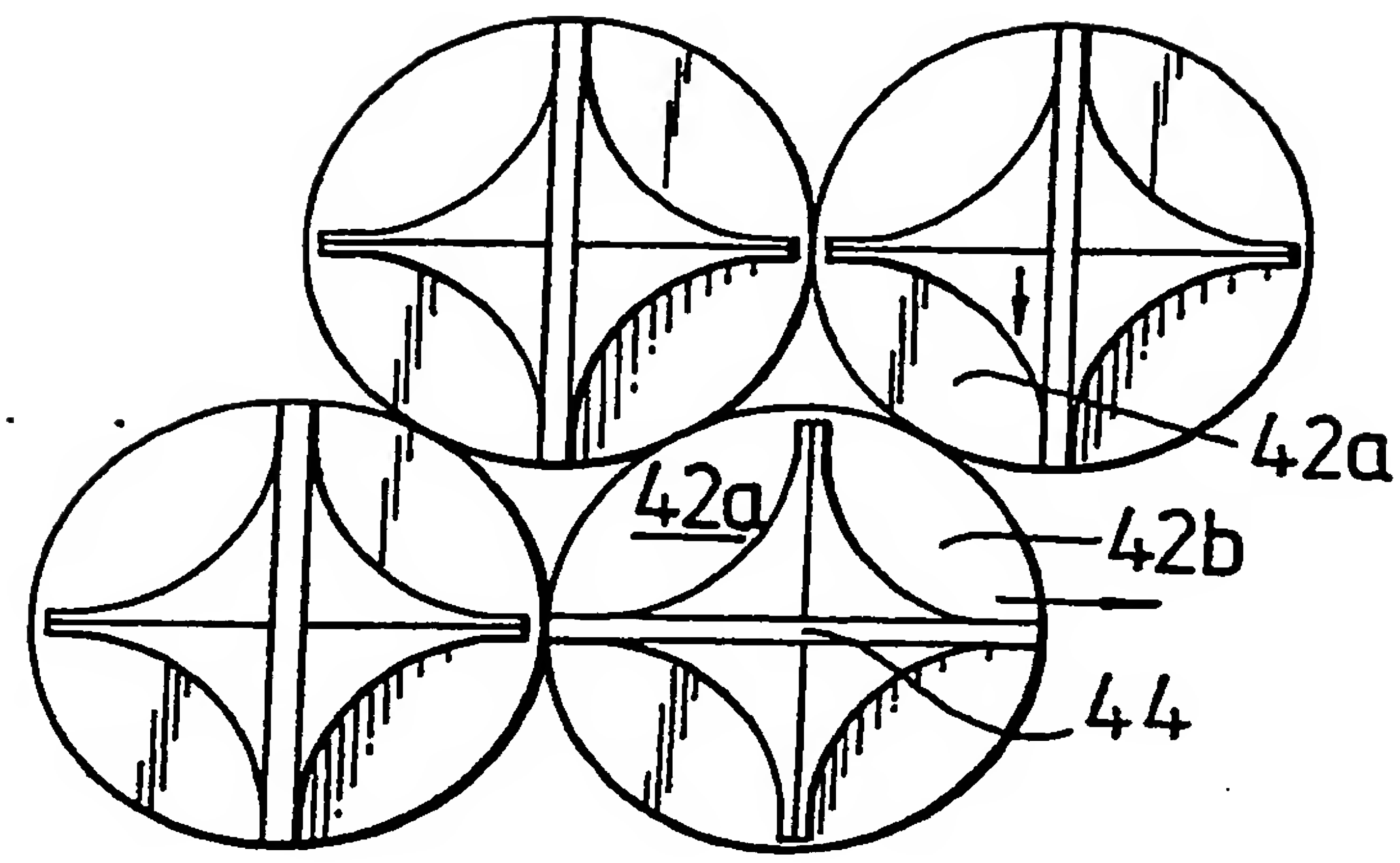


Fig.9a.

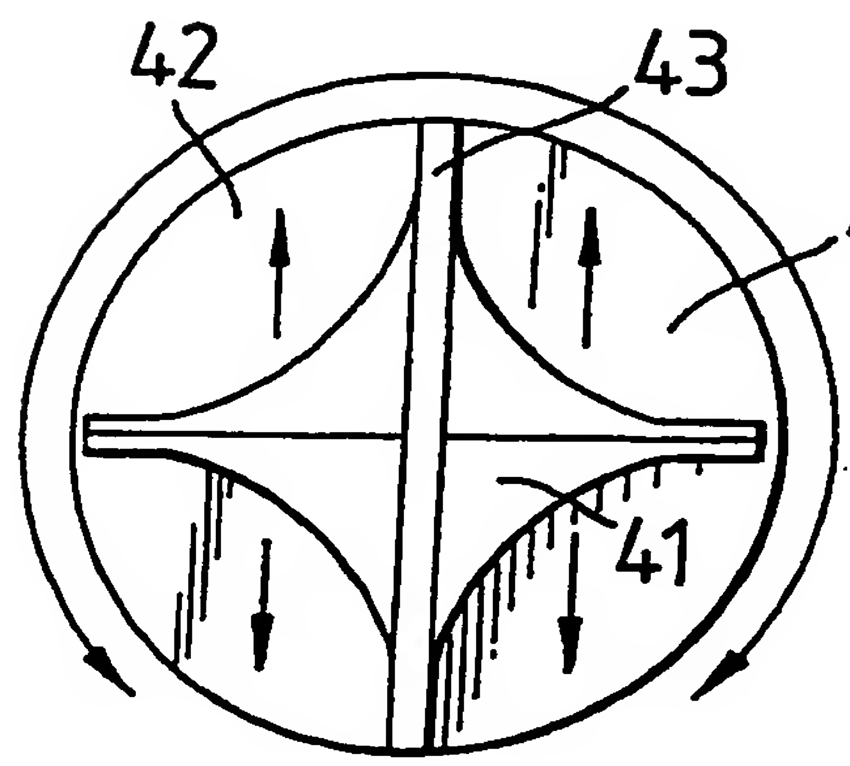


Fig.9c.

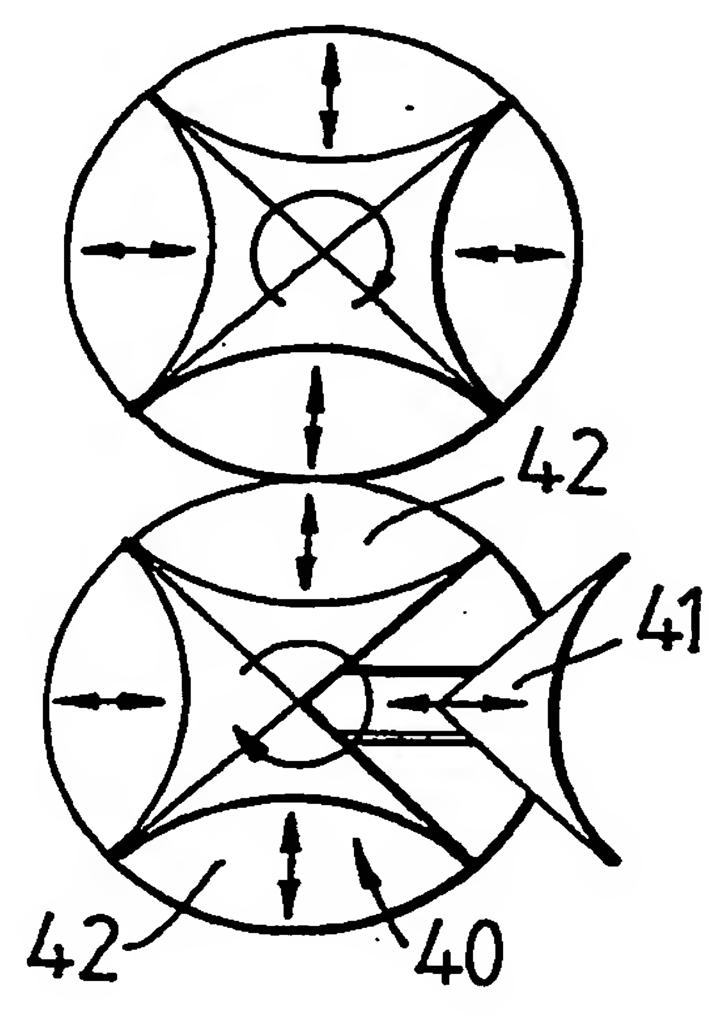
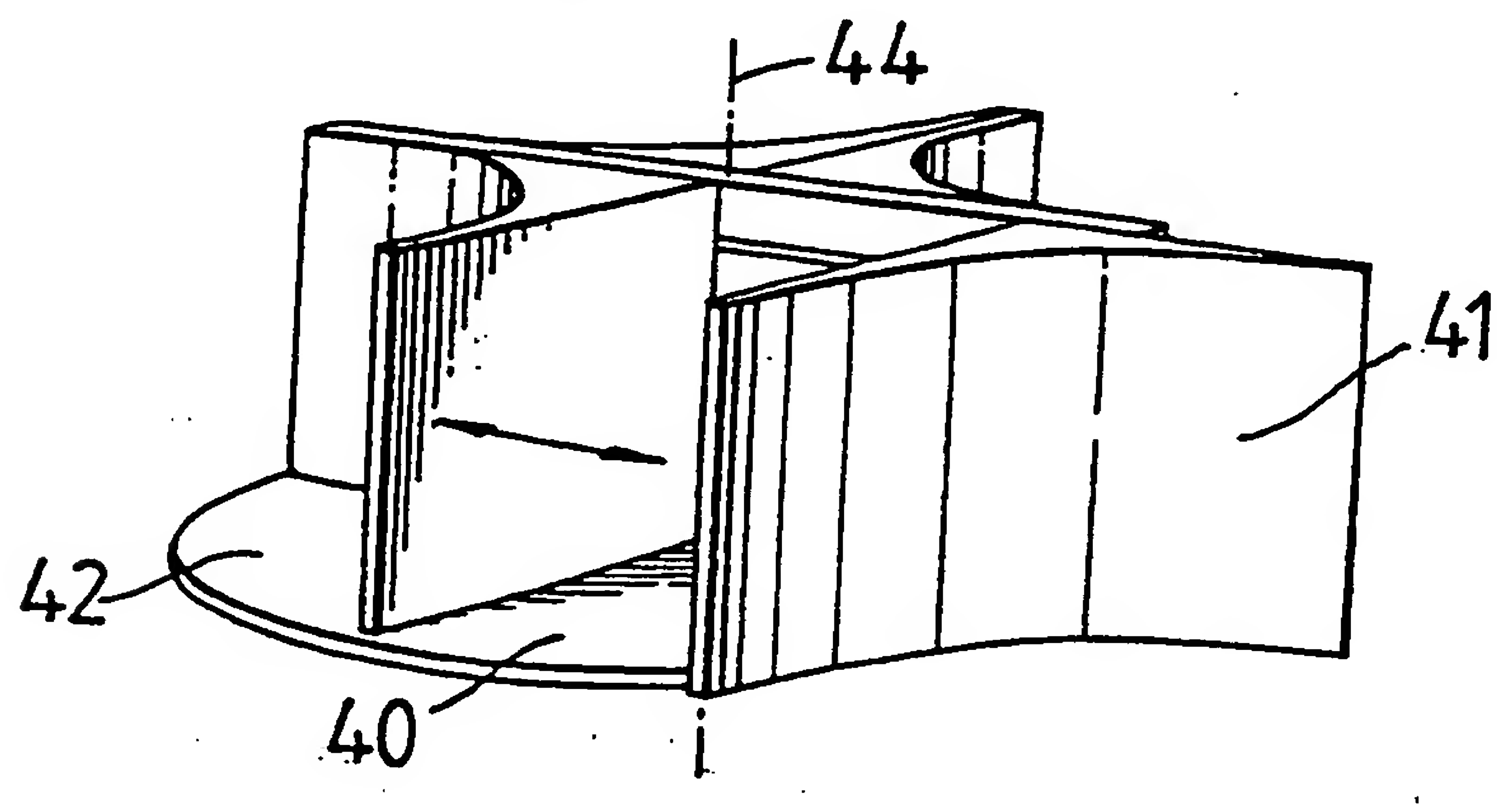


Fig.9b.



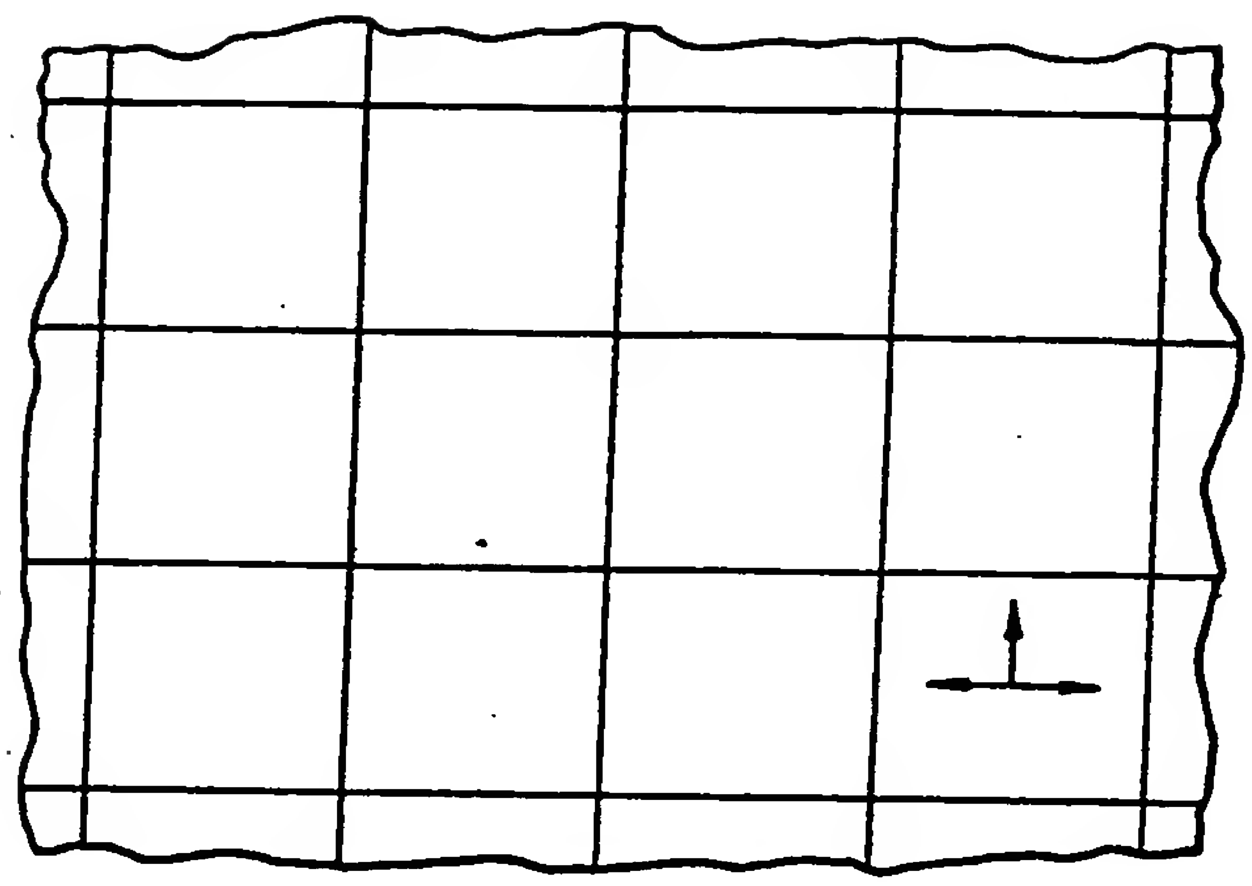
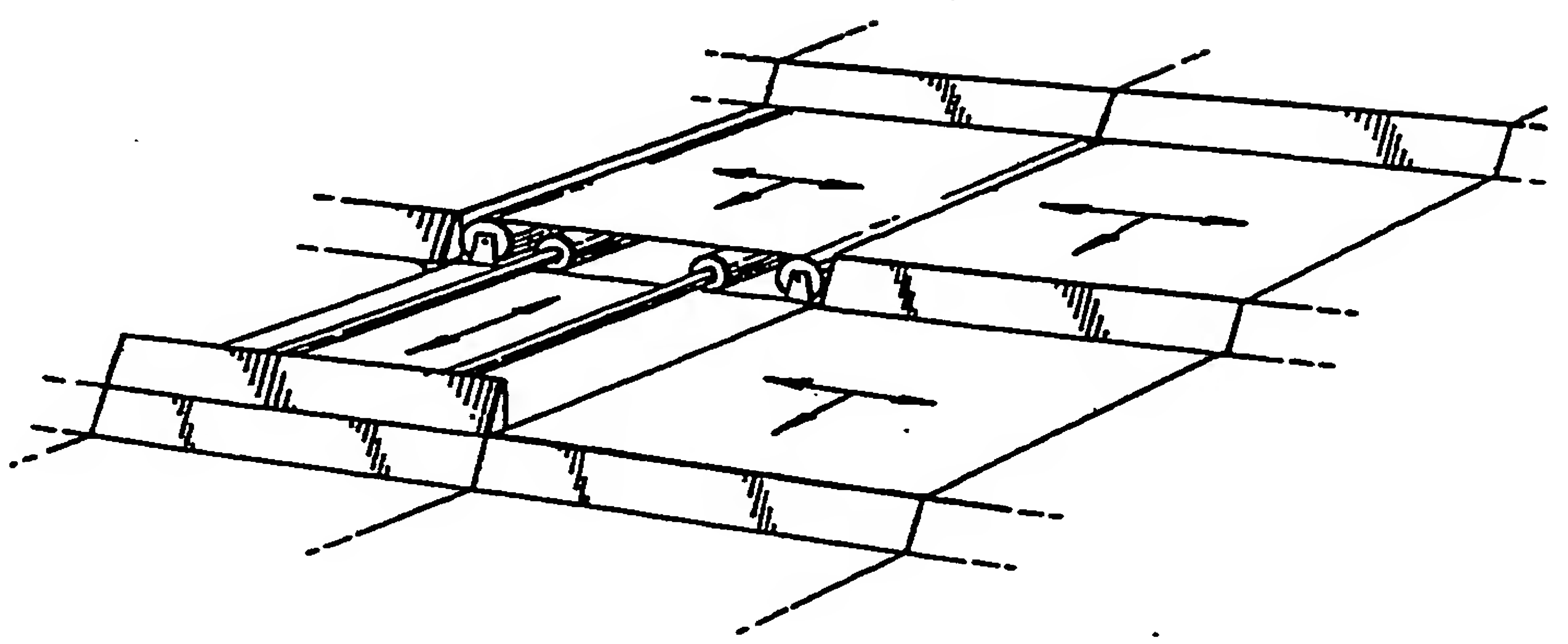
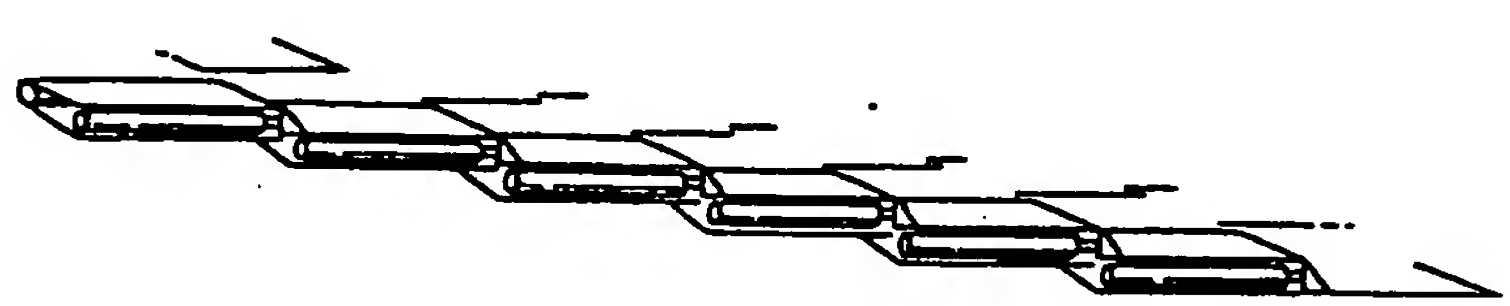
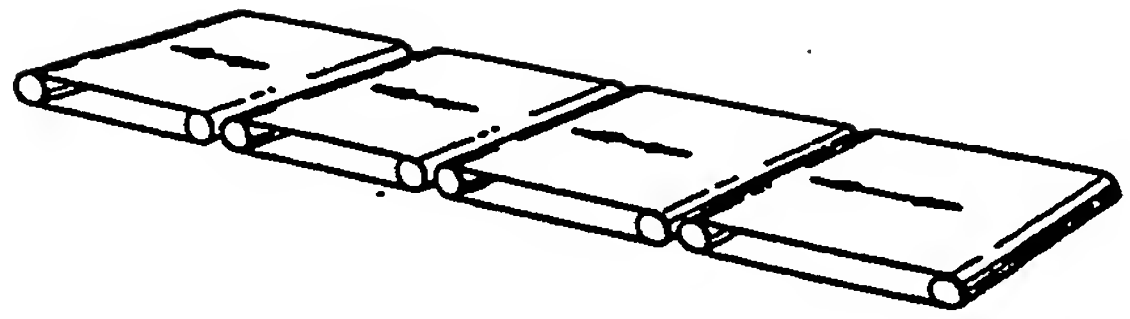


Fig. 10.







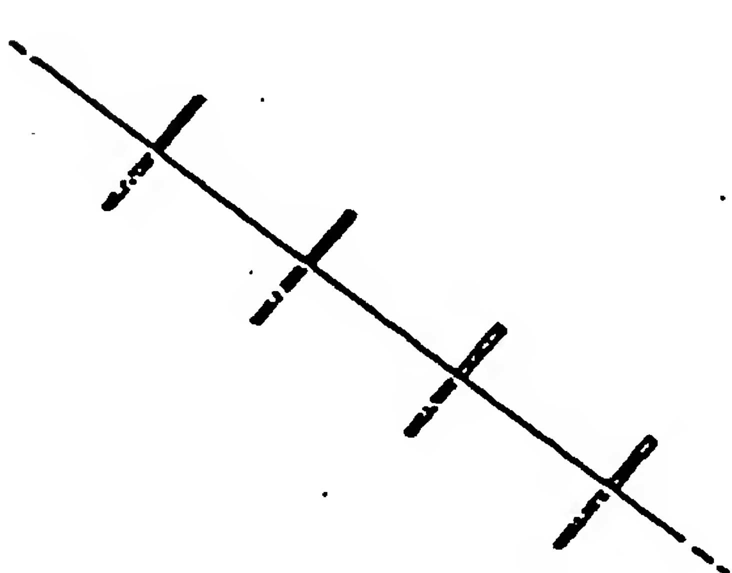


Fig. 11.

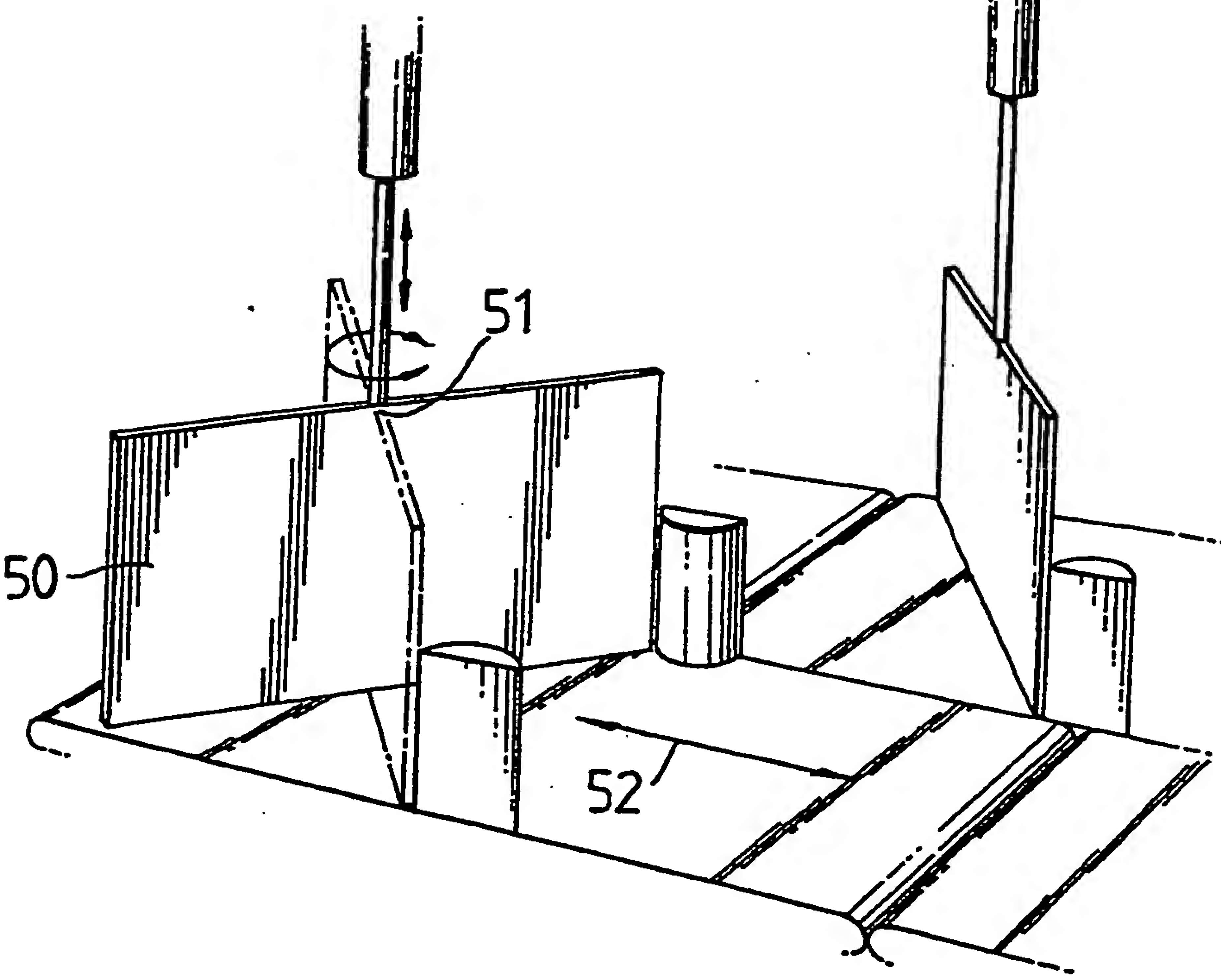


Fig. 11a.

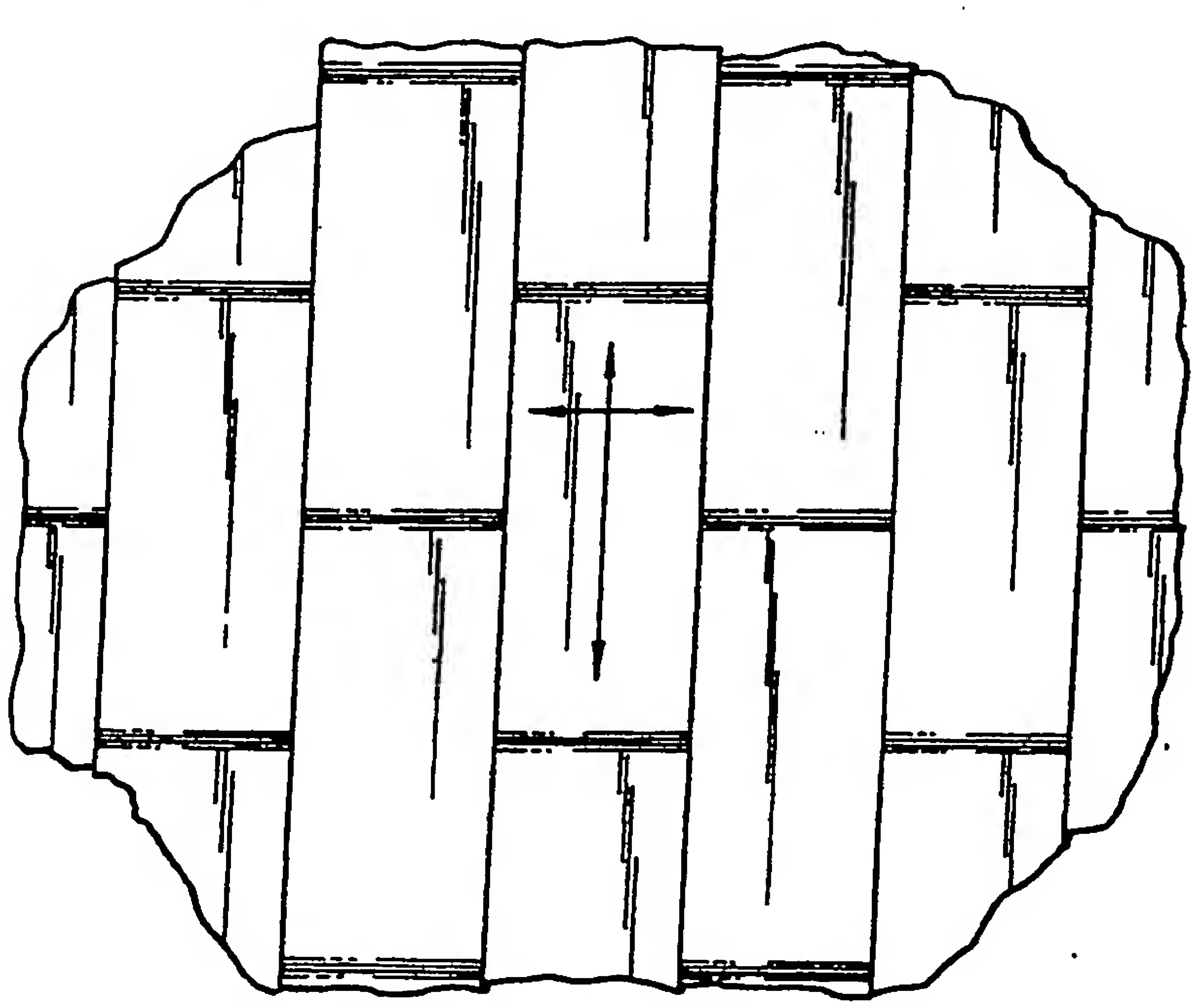
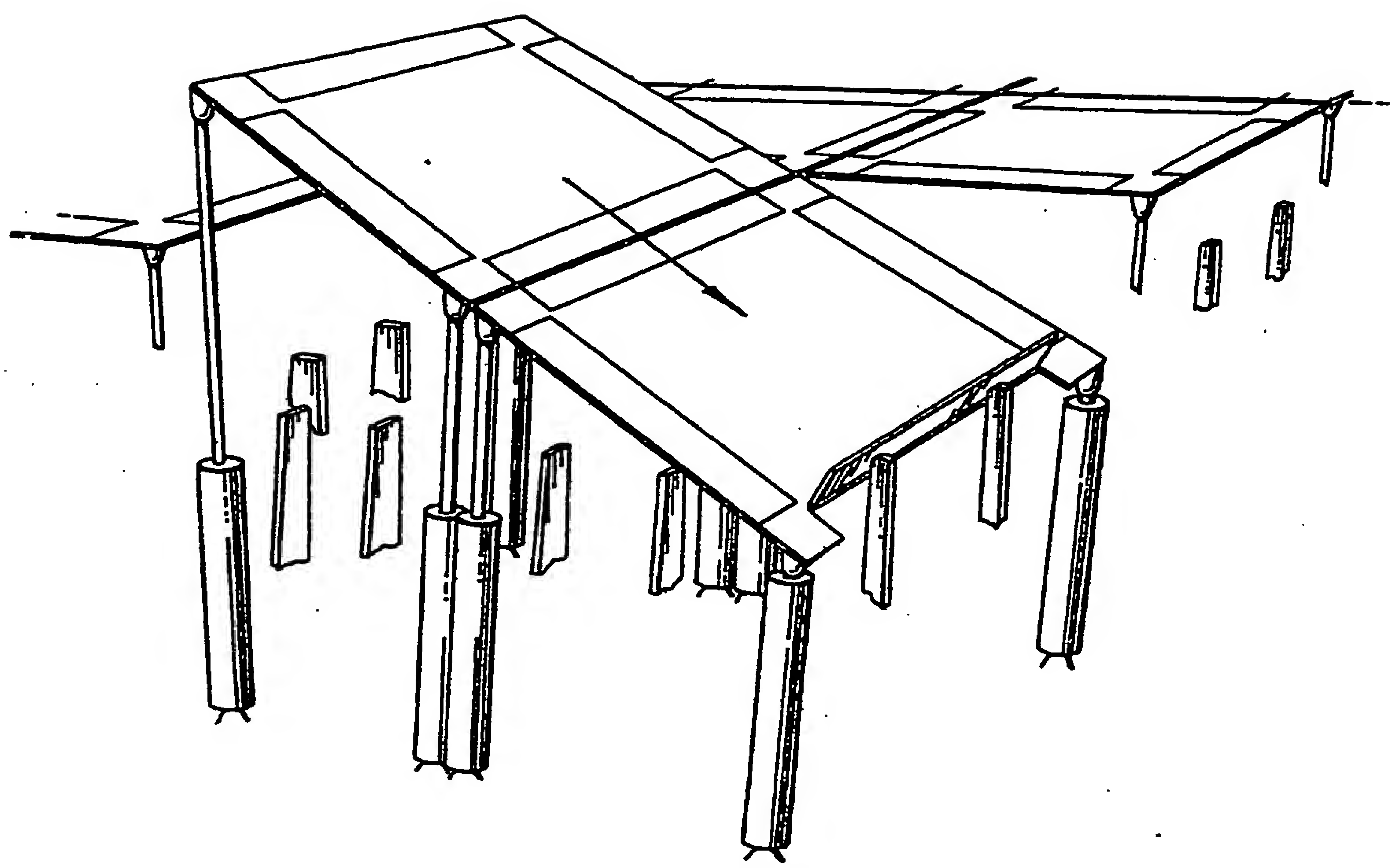
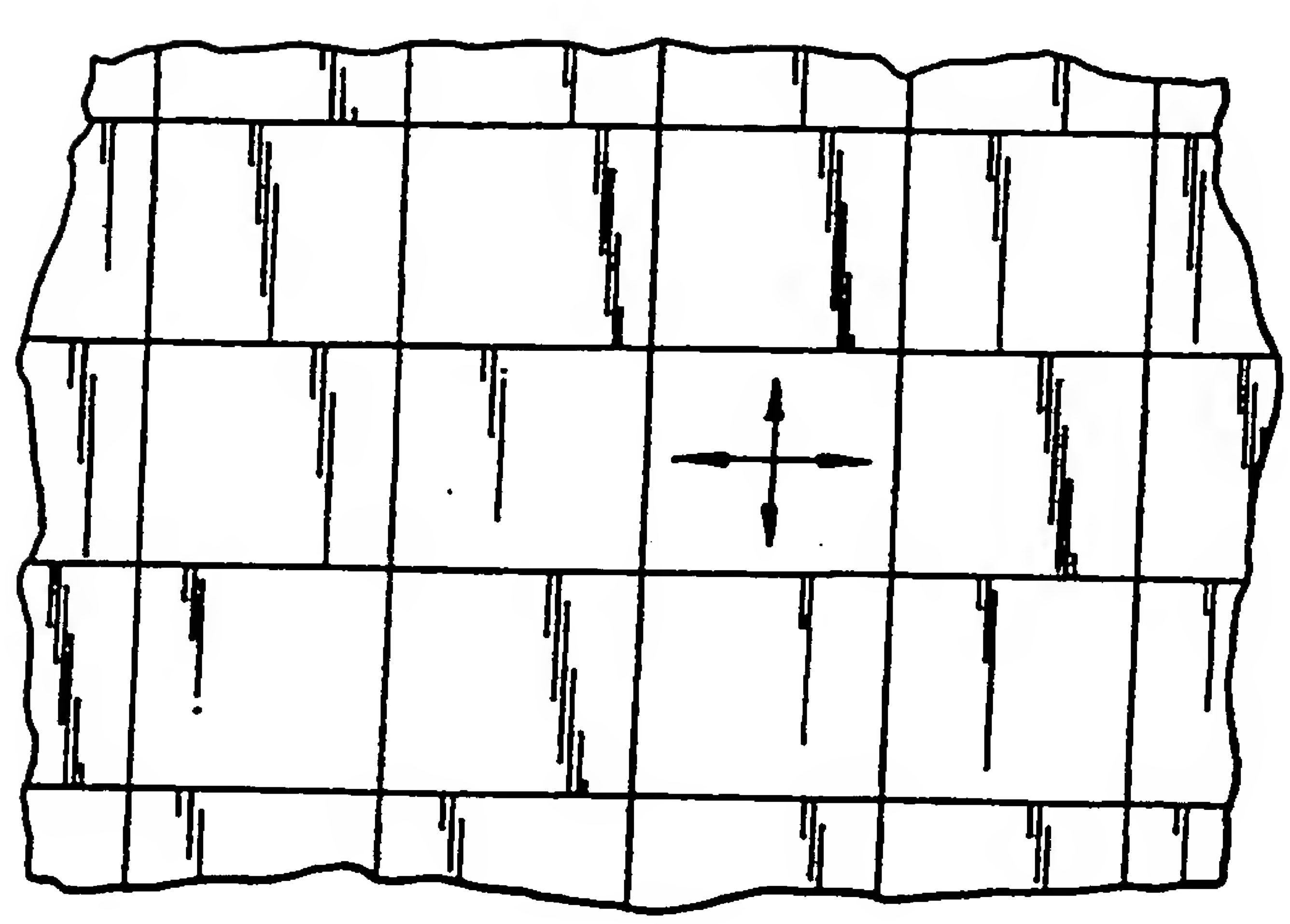


Fig. 12.





Distribution Apparatus

We, Parcel Force, a division of The Post Office, do hereby declare our invention relating to distribution apparatus, and particularly but not exclusively, to apparatus for sorting a plurality of discrete loads such as parcels, which must be sorted into different destinations, for onward transmission.

One known form of sorting apparatus comprises an endless conveyor, onto which the loads to be sorted are input, and a plurality of output conveyors typically leading at right angles away from the main conveyor, each output conveyor being indicative of a particular destination. The loads on the input conveyor are diverted onto the appropriate output conveyor. The destination of each load in input into a control system as the load is placed on the input conveyor and the appropriate diverting apparatus serves to divert the load onto the appropriate output conveyor. Typically, the diverting means may comprise a physical barrier placed on the conveyor to deflect the load, or the input conveyor may be tilted to tip the load onto the appropriate output conveyor. Such known systems have the disadvantages that they take up a large amount of floor space, particularly when a large number of output conveyors are required. This known system also lacks flexibility.

The present invention seeks to provide distribution apparatus which is more flexible and takes up less floor space for a given throughput than the known apparatus.

According to the present invention there is provided distribution apparatus including at least one input station for receiving a load, a plurality of output stations, a plurality of transfer stations each adapted to transfer loads therein in a selected one of a plurality of directions, and control means to direct said load from said input station to a predetermined one of the output stations via a plurality of said transfer stations.

Preferably, the apparatus includes a plurality of input

stations. In a preferred embodiment, the input and output stations may also comprise transfer stations. The or each of the input stations may be selectively adapted to form an output station, or vice versa. Preferably, a plurality of the transfer stations are juxtaposed to form a matrix. In one preferred form, the matrix consists of a substantially two-dimensional twelve by twelve rectangular array. In this case, a plurality of the transfer stations, which may be alternate stations, along one side of the array may form input stations, output stations being formed on the two adjacent sides. The side opposite said one side may also provide a plurality of input stations. It is also envisaged that at least one side of the array may have both input and output stations.

Each transfer station may comprise a module selectively removable from the array for repair or replacement or a plurality of transfer stations may be incorporated in such a module. The apparatus may include a single supporting surface extending over the array and comprising a planar surface, each transfer station comprising a device mounted over the surface and having means thereon to move the loads across the surface over a distance defining the transfer station for movement between the different stations. Alternatively, each individual transfer station has a load supporting surface and means adapted to move a load thereon out of the station onto an adjacent station, the load supporting surface of adjacent stations being contiguous.

According to a preferred aspect of the invention, there is provided a load supporting surface for a transfer station comprising three sets of conveyor rollers, each set comprising a plurality of rollers in spaced parallel relationship having a triangular configuration, the apices of the sets of rollers being juxtaposed in the centre of the load supporting surface, drive means being provided for each set of rollers to rotate the rollers in each direction of rotation, selectively.

According to another aspect of the present invention

there is provided a load supporting surface adapted to be oscillated in a horizontal plane by first oscillating means and oscillated in a vertical direction by second oscillating means, the oscillatory movement in the two planes being synchronised in a predetermined manner to thereby direct a load placed on the load supporting surface in a predetermined direction.

The size of the matrix will be determined, for example, by the number of input stations required, and the number of output stations as well as the parcel throughput required. Although described as a regular twelve by twelve matrix its general shape and size may be varied in dependence upon site parameters and operational requirements.

Preferred embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 shows a matrix for a distribution system formed of triangular units, each triangular unit consisting of three sets of driven rollers,

Figure 2 shows a matrix of square units each incorporating an oscillatory motion,

Figure 3 shows a matrix of transfer stations having a conveyor of roller sections,

Figure 4 shows a hexagonal matrix with transfer stations formed of circular plates incorporating one or more conveyor belts,

Figure 5 shows a transfer station having a belt conveyor adapted to be pivoted about a vertical axis,

Figure 6 shows a matrix having transfer stations with four tilting trays,

Figure 7 shows an arrangement of transfer stations each having rollers and belts to provide drive in four directions,

Figure 8 shows a matrix of square units in which each transfer station has a part spherical surface and pivotable paddles to transfer loads between adjacent stations,

Figure 9 shows an embodiment in which the transfer

stations incorporate a plurality of sweepers or pushers,

Figure 10 shows a further embodiment in which each transfer station includes a belt conveyor for movement in one plane and rams for moving items in a direction perpendicular to the movement of the belt conveyor,

Figure 11 shows an arrangement incorporating a plurality of diverters and,

Figure 12 shows an alternative arrangement in which loads are transferred between transfer stations by the use of tilting surfaces.

Figure 1 shows, in schematic form, part of a parcel sorting apparatus which consists of a matrix of triangular units which typically may form a two-dimensional array of twelve by twelve units. Each triangular unit comprises a transfer station. Those referenced 1, 2 and 3 typically comprise input stations, those referenced 4 and 5 output stations. In a parcel sorting system having an array of twelve by twelve transfer stations it is envisaged that three or more, and preferably alternate ones, of the transfer stations on one side of the array would comprise input stations and three or more of the transfer stations on the two adjacent sides would form output stations. It is also envisaged that some of the transfer stations on the side opposite the said one side may also form input stations. However, it is also envisaged that both input stations and output stations may be provided on one side, or more sides, of the array.

In the embodiment of Figure 1, each transfer station is triangular in plan and consists of three sets of driven rollers 6, 7 and 8 arranged with their apices juxtaposed in the middle of the station. Each set of rollers comprises a plurality of juxtaposed parallel rollers which are drivingly connected together for rotation, selectively, in each direction. The schematic sketches on the right-hand side of Figure 1 illustrate the different directions in which a load can be transferred out of the station. The arrows within the triangles indicate the direction of rotation of the

three sets of rollers and the arrow outside the triangle indicates the direction in which the load is moved out of the station.

Referring now to Figure 2, there is shown a matrix of square units which, again, is typically arranged in a two-dimensional array of twelve by twelve, that is a total of 144 transfer stations. Each station is typically about one metre square. In this embodiment, each transfer station has a substantially rectangular flat planar load supporting surface which is capable of being oscillated in a horizontal plane, typically by being oscillated about a three inch radius. Simultaneously, the load supporting surface is oscillatable in a vertical plane. By controlling the synchronisation of the orbital and vertical oscillations, it is possible to direct a load resting on the load supporting surface in any desired direction. In this application, the synchronisation between the oscillatory movements, which may be achieved either electronically or mechanically, is chosen so that loads on the surface can be transferred to adjacent transfer stations in any one of the four directions indicated by the arrows in the sketch of the matrix.

Referring now to Figure 3, there is shown a further embodiment in which the transfer stations each comprise a square or rectangular unit which typically may be arranged in an array of twelve by twelve stations. In this embodiment, the load supporting surface of each transfer station consists of an endless belt rotatable by rollers 11 and 12 in two directions indicated by the double-headed arrow 13. The conveyor belt consists of a plurality of strings of small rollers 14 which are rotatable in a direction at right angles to the direction indicated by the arrows 13 by means of a further belt conveyor 15 located between the two rollers 11 and 12. By this means movement can be obtained in the two mutually perpendicular directions.

Referring now to Figure 4, there is shown an alternative embodiment in which each transfer station has a

load supporting surface in the form of a circular plate, the transfer stations being arranged in a hexagonal matrix. As shown in subfigures 4a, 4b and 4c, each transfer station includes one or more conveyor belts and is pivotable about a vertical axis so as to enable loads on the station to be transferred to the appropriate adjacent station. In the version shown in figure 4a which is envisaged as being suitable for smaller, low capacity applications, the plate includes a conveyor belt movable in two directions and the plate itself is pivotable into a selected one of three positions 60° apart from each other. In this way, by reversing the direction of movement of the belt conveyor loads on the plate can be transferred to any one of the six adjacent transfer stations.

Figure 4b shows an alternative version intended for medium sized and medium capacity sorting apparatus and includes two curved conveyor belts. A third version shown in Figure 4c includes two curved conveyor belts and a central straight conveyor belt each of which belts is movable in two directions. With these latter two embodiments, the frequency of pivotable movement of the circular plate in practice can be reduced.

Figure 5 discloses an alternative embodiment in which each transfer station includes a belt conveyor extending substantially over its entire surface. The stations therefore form a square unit to form a square matrix. Each belt conveyor, which forms the load supporting surface, mounted on a ram so as to be raised and/or lowered. As shown in the schematic perspective view, in order to direct a load on the conveyor in a direction at 90° to the direction of rotation of the belt conveyor, it is necessary to raise or lower the conveyor out of the plane of the adjacent transfer stations to enable the conveyor to be pivoted through 90°. The load thereon can then be transferred laterally to the direction in which it entered the transfer station.

Figure 6 shows a further embodiment in which each

transfer station comprises a carousel. Each transfer station has a load supporting surface comprising four individually tiltable trays, indicated as reference 20, which are pivotable about their outer edge 21 to an upper position as shown at reference 20a. The carousel therefore has four package receiving zones located at 90° from each other with side walls 22 formed by the main body 23 and a curved inner wall 24 which prevents any loads on the trays from falling off the inner side edge of the tray 20. In operation, when it is desired to transfer a load from one station to an adjacent station the tray carrying the load is brought into alignment with a vacant tray on the selected adjacent transfer station and, simultaneously, the tray 20a carrying the load is tilted upwards by pivotal movement about its inner edge and the tray on the receiving transfer station is tilted downwards by pivotal movement about its outer edge, as shown by the tray having reference 20b. Once the load has entered the receiving transfer station the tray 20b is moved to the horizontal position whilst the transfer station moves to pass the load onto the next station.

Figure 7 discloses an alternative embodiment in which the transfer stations are again made out in a square matrix or chequer board pattern and in this embodiment, the load supporting surface of each transfer station consists of a plurality of relatively narrow belt conveyors 25 which rotate in synchronism to transfer a load thereon in either of the directions shown by the arrows 26. Interspersed with the belt conveyors 25 there are a plurality of sets of roller conveyors 27 which are arranged to enable loads to be transferred across the transfer station in the directions indicated by the arrows 28. The sets of roller conveyors 27 are mounted on a subframe which may be raised and lowered so that when the frame is raised, the sets of rollers 27 are raised above the surface of the belt conveyors 25. The rollers 27 are then simultaneously rotated to drive a load in the selected one of the directions indicated by the double headed arrow 28. In this way a load on the load

supporting surface can be transferred to an adjacent transfer station in any one of four mutually perpendicular directions.

Figure 8 shows a further embodiment in which each transfer station has a substantially square load supporting surface arranged in a square matrix. In this embodiment, the load supporting surface has a part-spherical shape which is swept in two mutually perpendicular planes by two paddles 30 which are pivotally mounted above the surface so as to be pivotable about axis 31 to thereby enable the paddle 30 to sweep across the surface transferring a load thereon onto an adjacent transfer station. The paddles are such that their centre of pivotal movement is at the centre of the sphere from which the load supporting surface is generated so that even small parcels on the surface are transferred reliably. The paddles 30 are adapted to transfer loads in either of the two directions and can be elevated out of the way prior to a parcel arriving in the station. With this embodiment the loads or parcels arriving in the transfer station will tend to find the centre of the load supporting surface because of the curvature.

Figure 9 shows a further embodiment of the transfer station in which a load supporting surface 40 is essentially circular so that in this embodiment the transfer stations are arranged in a hexagonal pattern. A plurality of ploughs or pushers 41 are mounted on the surface 40 to define regions 42 for receiving a load. The pushers or ploughs can operate in a number of ways. In Figure 9a, and 9b, the pushers 41 slide relative to a central wall 43 which is mounted on, and extends diametrically across, the plate 40. The ploughs 41 slide along the wall 43 in both directions so that a load on the region 42a of one transfer conveyor would be transferred to the load supporting area 42b of the adjacent transfer station. In the part of the matrix illustrated the load on the part 42b could then be transferred laterally in the direction of the arrow. In order to transfer the load in any other direction, the

transfer station is pivoted about its central axis 44. Figure 9c illustrates an alternative embodiment in which the transfer station has four ploughs 41 which are movable radially, inwardly and outwardly as indicated by the arrows. In this embodiment the transfer station also pivots about its central axis 44 to align a load on the transfer station with a desired adjacent transfer station. In this version, the transfer stations are arranged in a square grid pattern instead of a hexagonal pattern.

Referring now to Figure 10 there is shown an alternative embodiment in which the matrix is formed of transfer stations having essentially square load supporting surfaces each of which consists of a belt conveyor section. The belt conveyors are arranged in rows in which the conveyors are linearly aligned and are all arranged to drive in a selected one of the two directions. The belt conveyors of each transfer station are driven by two belt drive rollers located at the edges of the transfer station. Within the space enclosed by the belt and the rollers each transfer station has a pusher or plough, driven by a pair of air cylinders, which is arranged to sweep over the surface of a belt conveyor of a transfer station in an adjacent row. The adjacent rows of belt conveyors are therefore located in a stepped manner to form a cascade. Loads are transferred along the rows of belt conveyors by rotating the conveyors in the usual way but if it is desired to move a load in a direction transverse to the direction determined by the row of belt conveyors, the plough on the selected transfer station on the row above the row carrying the load is operated to push the load off the row on which it lies to the next lower row. Recirculation zones can be provided to transfer loads to the top of the cascade if this is required. Alternatively, the load supporting surfaces of the rows of belt conveyors may be inclined to the horizontal so that, overall, the entire matrix has a generally horizontal configuration. In an alternative version of the cascade principle, the rows of belt conveyors are inclined

at an angle laterally and loads are maintained thereon by gates shown schematically in Figure 10. When it is desired to transfer a load laterally onto an adjacent row of belt conveyors, the gate is removed either by lifting it out of the way or dropping it down below the load supporting surface of the belt conveyors. The loads thereon can then slide onto the adjacent row.

Figure 11 shows an alternative embodiment in which the transfer stations each consist of a rectangular unit incorporating a belt conveyor. The transfer stations of adjacent rows are offset by half the length of a station to form a matrix as shown in Figure 11a. Each transfer station incorporates at least one diverter which is preferably in the form of a diverter plate 50 which is pivotable about its central axis 51 so as to deflect parcels transferring along the conveyor in the direction of the arrow 52 onto an adjacent transfer station. When it is desired to pass a load directly along the transfer station in the direction on the arrows 52, the diverter plate 50 can be raised clear by means of a pneumatic actuator 53. Two such diverter plates 50 may be provided at each transverse station for maximum flexibility. Alternatively, the diverter plate may be moved laterally along the transfer station longitudinal axis to deflect packages onto a selected one of the adjacent transfer stations.

Figure 12 shows a further embodiment in which each transfer station has a substantially square load supporting surface arranged in a matrix with a chequer board layout. In this embodiment, each load supporting surface is supported on four linear pneumatic rams located adjacent the corners of the surface. In order to transfer a package in a transfer station to the adjacent transfer station the load supporting surface is tilted by extending the actuators on one side to tilt the surface in the required direction. The load supporting surface of the adjacent, receiving, transfer station is tilted downwardly by retraction of the actuators on the side remote from the transfer station from which the

load is to be transferred. Each edge of the load supporting surface has a hinged stop plate which, when the side of the load supporting surface is lowered abuts a stop located under the supporting surface so that the hinged plate is pivoted upwardly to provide a stop to prevent a load falling off the transfer station. Once it is located on the new site, the actuators are extended to move the load supporting surface up to the horizontal position from where the load can be transferred to the next desired transfer station.

The movement of loads across the transfer station between the inlet and outlet stations is controlled by a computerised control system.

The control system may include a computer adapted to control the distribution apparatus. The computer may include a computer program which simulates the distribution apparatus. User inputs of the program will normally define the number of loads input, which input station a particular load is input from, and the output destination of a particular load. The user inputs may be on the loads and a sensor used to transfer the user information to the computer. The computer program is preferably adapted to use the user inputs to define the input and output matrices of the distribution apparatus. The computer program is further adapted to determine a transfer matrix for transforming the input matrix into the output matrix. The computer is preferably adapted so that the computer program can produce transfer outputs, which transfer outputs are adapted to control the individual stations of the distribution apparatus. The transfer outputs may be determined from the transfer matrix. The computer program may be adapted so that the user inputs are used to produce a plurality of transfer matrices, for example a transfer matrix representing each station of the distribution apparatus the computer program can produce.

In any case, a transfer matrix or transfer matrices which is/are adapted so that the distribution apparatus will distribute, in use, loads from the input to the output

station in such a way that a group of loads are distributed in minimum time, or that loads from a particular input station are distributed most quickly, or loads for a particular output are processed most quickly. The computer program may form transfer matrices which are adapted to follow any load distribution plan which is desirable.

The distribution apparatus will transfer loads in accordance with the computer program that comprises the control means. Therefore, the individual station will transfer loads in such a way that the desired load distribution plane is followed. By way of example, a computer program which simulates the distribution apparatus follows.

In this program the variables have been set to correspond to a small distribution apparatus. No priority for a load distribution plan has been determined and the term parcel is used to indicate a load.

CLAIMS

1. Distribution apparatus including at least one input station for receiving a load, a plurality of output stations, a plurality of transfer stations each adapted to transfer loads therein in a selected one of a plurality of directions, and control means to direct said load from said input station to a predetermined one of the output stations via a plurality of said transfer stations.

2. Apparatus according to claim 1, which includes a plurality of input stations.

3. Apparatus according to claim 1 or 2, in which the input and output stations may also comprise transfer stations.

4. Apparatus according to claim 1, 2 or 3, in which the or each of the input stations is selectively adapted to form an output station, or vice versa.

5. Apparatus according to any one of claims 1 to 4 wherein a plurality of the transfer stations are juxtaposed to form a matrix.

6. Apparatus according to claim 5, wherein the matrix consists of a substantially two-dimensional rectangular array.

7. Apparatus according to claim 6, wherein a plurality of the transfer stations along one side of the array form input stations, output stations being formed on the two adjacent sides, or on the side opposite said one side.

8. Apparatus according to claim 7, wherein one side of the array has both input and output stations.

9. Apparatus according to any one of claims 1 to 8, wherein each transfer station comprises a module selectively removable from the apparatus for repair or replacement.

10. Apparatus according to any one of claims 1 to 8 wherein a plurality of transfer stations are incorporated into a module selectively removable from the apparatus for repair or replacement.

11. Apparatus according to any one of claims 1 to 10, comprising a planar supporting surface extending over the array, each transfer station comprising a device mounted over the said surface and having means thereon to move the loads across the surface over a distance defining the transfer station, for movement between the different stations.

12. Apparatus according to any one of claims 1 to 10, in which each individual transfer station has a load supporting surface and means adapted to move a load thereon out of the station onto the load supporting surface of an adjacent station, the load supporting surfaces of adjacent stations being contiguous.

13. Apparatus according to any one of claims 1 to 10, wherein the load supporting surface of each transfer station comprises three sets of conveyor rollers, each set comprising a plurality of rollers in spaced parallel relationship having a triangular configuration, the apices of the sets of rollers being juxtaposed in the centre of the load supporting surface, drive means being provided for each set of rollers to rotate the rollers thereof in each direction of rotation, selectively.

14. Apparatus according to any one of claims 1 to 10, wherein the load supporting surface of each transfer station is adapted to be oscillated in a horizontal plane and also

oscillated in a vertical direction, the oscillatory movement in the two planes being synchronised in a predetermined manner to thereby direct a load placed on the load supporting surface in a selected predetermined direction.

15. Apparatus according to any one of claims 1 to 10, wherein the load supporting surface of each transfer station is supported on four extensible ram-and-cylinder devices selectively operable to tilt the surface in a desired direction.

16. Apparatus according to any one of claims 1 to 10, wherein the transfer stations are arranged in a plurality of rows, the rows being positioned as a cascade with successive rows being lower than the preceding row, each station having means to move a load from the station onto an adjacent station on the next lower row.

17. Apparatus according to any one of claims 2 to 16, wherein the transfer stations are arranged in a twelve by twelve matrix.

18. Distribution apparatus including at least one input station for receiving a load, a plurality of output stations, a plurality of transfer stations each adapted to transfer loads therein in a selected one of a plurality of directions, and control means to direct said load from said input station to a predetermined one of the output stations via a plurality of said transfer stations, wherein the load supporting surface of each transfer station is adapted to be oscillated in a horizontal plane and also oscillated in a vertical direction, the oscillatory movement in the two planes being synchronised in a predetermined manner to thereby direct a load placed on the load supporting surface in a selected predetermined direction.

19. Distribution apparatus substantially as described herein, with reference to, and as illustrated in, the accompanying drawings.

20. Distibution apparatus according to any one of the preceding claims, including a computerised control system for controlling the movement of loads and directing each load to the desired output station.

21. Apparatus according to claim 20, wherein the control system includes identity means on each load indicative of the output station to which the load is to be directed, and means to read said identity means, the computer being programmed to direct the load to the output station in a predetermined manner.

22. Apparatus according to claim 21, wherein said predetermined manner is the shortest route distance or the quickest time.

23. Apparatus according to claim 21 or 22, wherein said identity means includes means indicating a load to be given priority.

24. Apparatus according to any one of claims 20 to 23 in which the control system includes program means to determine which stations are to be input stations and/or output stations.

25. Distribution apparatus according to any one of claims 20 to 24 and substantially as described herein, with reference to, and as illustrated in, the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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(ii) Int Cl (Edition 5) B65G, B07C

Search Examiner

B J THOMAS

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

23.11.92

Documents considered relevant following a search in respect of claims 1-25

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2053828 (S.I.F.A.R.) see figures 1 and 4 and lines 121-130 page 1	1,2,5-7 9-12
X	GB 1397017 (BAUER) see figures 4 and 11 and page 5 lines 6-30	1
X	GB 921571 (PAPER SACKS) see figures 1 and 2	1,5,6
X	GB 765013 (UNILEVER) see figures 1 and 2	1,2,5,6
X	GB 205447 (HUELINGS) see figure 10	1

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Category	Identity of document and relevant passages	Relevant to claim(s.

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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